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## **Use of Ground Penetrating Radar for Locating Contraband Aboard Ocean Going Vessels: Feasibility Study**

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August 2001

**Geotechnical and Structures  
Laboratory**

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# Contents

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Preface .....	v
Executive Summary .....	vi
Conversion Factors, Non-SI to SI Units of Measurement .....	viii
1—Introduction .....	1
Background .....	1
Ground Penetrating Radar Principles and Equipment .....	1
2—GPR Field Tests .....	5
Initial Investigations .....	5
Crystal gypsum pile.....	5
Powdered gypsum pile .....	6
Crushed pumice pile .....	10
Coarse coal pile .....	12
Buried Contraband Simulant Tests.....	13
Crystal gypsum pile.....	14
Powdered gypsum pile .....	14
Crushed pumice pile .....	17
Bauxite pile.....	20
Coal pile.....	20
Terrain Conductivity Tests .....	24
3—Discussion of Results .....	26
4—Summary and Conclusions.....	28
Appendix A: Crystal Gypsum GPR Records – Initial Investigation.....	A1
Appendix B: Powdered Gypsum GPR Records – Initial Investigation .....	B1
Appendix C: Crushed Pumice GPR Records – Initial Investigation .....	C1
Appendix D: Coarse Coal GPR Records – Initial Investigation.....	D1
Appendix E: Crystal Gypsum GPR Records – Buried Contraband Simulant Test .....	E1
Appendix F: Powdered Gypsum GPR Records – Buried Contraband Simulant Test .....	F1

Appendix G: Crushed Pumice GPR Records – Buried Contraband Simulant Test .....	G1
Appendix H: Bauxite GPR Records – Buried Contraband Simulant Test .....	H1
Appendix I: Coal GPR Records – Buried Contraband Simulant Test.....	I1
SF 298	

# Preface

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Personnel of the U.S. Army Engineer Research and Development Center (ERDC) conducted a series of ground penetrating radar (GPR) surveys at the Alabama State Docks, Mobile, Alabama, during the period 20-22 September 2000. The work was funded by the U.S. Coast Guard Research and Development Center (R&DC), Groton, CT, under MIPR DTCG39-00-X-R00012, dated 13 April 2000.

The GPR surveys were conducted by Mr. José L. Llopis and Dr. Janet E. Simms, Engineering Geology and Geophysics Branch (EGGB), Geosciences and Structures Division (GSD), Geotechnical and Structures Laboratory (GSL), ERDC. Dr. Chih-Wu Su, U.S. Coast Guard R&DC, and Mr. Steve Rigdon, Anteon Corporation, Groton, CT, were project managers.

The work was performed under the direct supervision of Dr. Lillian D. Wakeley, Chief, EGGB, and under the general supervision of Drs. Robert L. Hall, Chief, GSD, and Michael J. O'Connor, Director, GSL.

At the time of publication of this report, Dr. James R. Houston was Director of ERDC, and COL John W. Morris III, EN, was Commander and Executive Director.

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# Executive Summary

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In January 2000 personnel of the U.S. Coast Guard Research and Development Center (R&DC), Groton, CT, and the U.S. Army Engineer Research and Development Center (ERDC), Vicksburg, MS, met to discuss possible methods to non-intrusively locate contraband aboard ocean going vessels. R&DC personnel were particularly interested in using current or developing technologies that could be used for this purpose. R&DC personnel stipulated that the equipment had to be compact, man-portable, be able to be used in confined areas of ships, be user-friendly, and the results easy to interpret. One of the methods that was agreed to show promise in locating contraband in the holds of ships was ground penetrating radar (GPR).

GPR surveys were conducted over various stockpiled materials at the Alabama State Docks located in Mobile, AL, to determine whether GPR is a viable method for rapidly detecting contraband materials buried in the cargo holds of ocean going vessels. The surveys were conducted by burying various objects including a contraband simulant (a bundle of four 10-lb bags of sugar duct-taped together) in stockpiled materials available at the site. The stockpiled materials tested were crystal gypsum, powdered gypsum, crushed pumice, coarse coal, fine coal, and bauxite.

Two GPR systems, the pulseEKKO 1000 and the Noggin Plus systems, manufactured by Sensors & Software, Inc., were used to conduct the surveys. Antenna frequencies ranged between 225 and 900 MHz. GPR surveys were run over the stockpiled materials using a suite of antenna frequencies to determine the effects of material type on depth of penetration and target resolution.

All of the antennas tested were successful in detecting the location of the contraband simulant in at least one of the stockpiled materials. The 225 and 250 MHz antennas had the highest percentage of detecting the simulant in the stockpiled materials (60 and 90 percent, respectively) whereas the 900 MHz antenna had the lowest (30 percent). All of the antennas tested have penetration depths of greater than 1.5 m.

The GPR surveys run on the different stockpiled materials at the Alabama State Docks demonstrate that GPR is a feasible means of locating contraband buried to depths of at least 1 to 2 m (limit of testing). However, the probability of success of locating contraband with GPR on board ships depends on the size and

depth of the target as well as the magnetic and electrical properties of target and the material in which it is hidden.

# Conversion Factors, Non-SI to SI Units of Measurement

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Non-SI units of measurement used in this report can be converted to SI units as follows:

Multiply	By	To Obtain
feet	0.3048	meters
inches	2.54	centimeters
ohm-feet	0.3048	millisiemens per meter
pounds (force)	4.44822	newtons

# 1 Introduction

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## Background

A series of ground penetrating radar (GPR) surveys were conducted in Mobile, AL, during the period 20-22 September 2000 in support of the U.S. Coast Guard Research and Development Center's (R&DC), Vessel Search Project. Personnel of the Geotechnical and Structures Laboratory (GSL), Engineer Research and Development Center (ERDC), Vicksburg, MS, conducted the GPR surveys. The purpose of the surveys was to determine the effectiveness of GPR in locating contraband buried in various types of bulk cargo materials.

## Ground Penetrating Radar Principles and Equipment

Traditionally, GPR has been used as a geophysical technique for subsurface exploration. GPR involves transmitting high-frequency electromagnetic (EM) pulses into a material. The GPR system consists of a transmitting and receiving antenna. When the transmitted EM signal impinges upon the boundaries of materials with contrasting electrical properties some of the EM signal is reflected back to the surface where it is detected by the receiving antenna. The time the signal takes to travel from the transmitting antenna, reflect off a boundary, and be detected by the receiving antenna are amplified, processed, and recorded to provide a "continuous" profile of the subsurface, as illustrated in Figure 1. The lack of coincidence between zero time and zero depth is due to the separation of the transmitter and receiver antenna. The first arrival at the receiver is the direct wave traveling from the transmitter to the receiver, not the reflection from the ground surface. The time span between zero time and zero depth is the one-way travel time of the direct wave between the transmitter and the receiver. The depth scale, in particular at very shallow depths, is nonlinear. The depth scale is based on the velocity of the transmitted EM pulse through the propagating media. Because the transmitter and receiver antenna are separated by a finite distance and the transmitted pulse has a lobe-shaped radiation pattern, the ray of the transmitted pulse that arrives at the receiver does not strike the subsurface interface at normal incidence, but at an acute angle. The depth scale is corrected for non-normal incidence of the transmitted ray path.



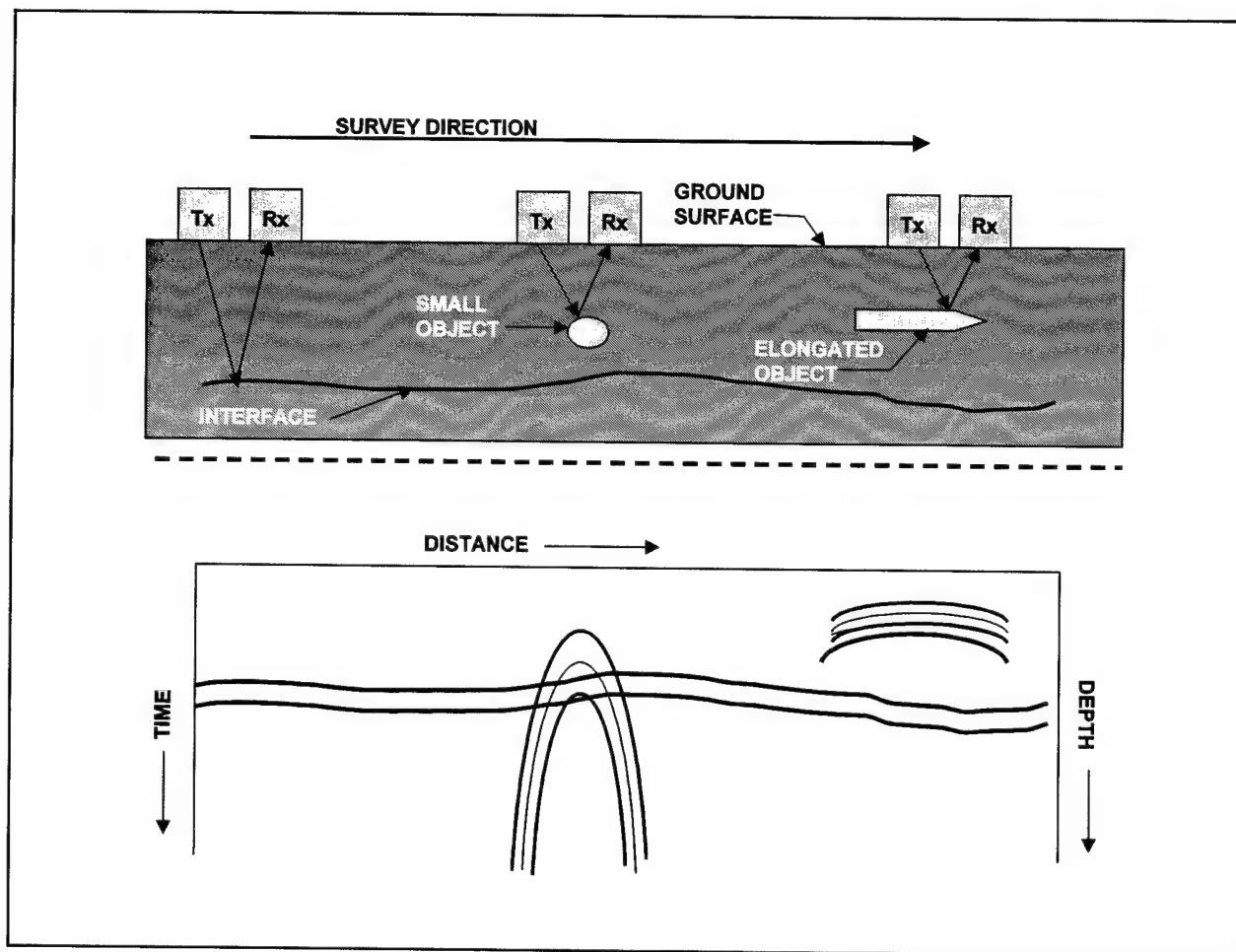


Figure 1. GPR concepts

The transmitted EM signals respond to changes in materials with sufficiently different electrical properties such as those caused by mineral content, salinity, water content, density, voids, etc. The depth of penetration and amount of definition that can be expected is determined by the electrical properties of the host material being tested as well as the power and frequency of the transmitting antenna. In general, the higher the conductivity of the host material is, the less the GPR depth of penetration. The primary disadvantage of GPR is its extremely site specific applicability. It is difficult to predict whether GPR will be successful in accomplishing its goal without prior knowledge of the electrical properties of the host materials.

Two Sensors and Software, Inc. GPR systems were used for these tests: a pulseEKKO (pE) 1000 and a Noggin Plus. Antenna frequencies of 225, 450, and 900 MHz were used with the pE 1000 while a 250 MHz antenna was used with the Noggin Plus system. The reflection profiling survey mode was used for these surveys. In this mode, the receiving and transmitting antennas are kept a fixed distance apart as the antenna pair is pulled along a survey line. Antenna separations of 0.5, 0.25, and 0.170 m were used with the 225, 450, and 900 MHz antennas, respectively. Although the pE 1000 system allows the flexibility to vary

the antenna separation, the antenna separations used in this study are those typically used in subsurface investigations. The antenna separation for the Noggin Plus 250 MHz antenna is a fixed 0.35 m.

As previously mentioned two different GPR systems were used, the pE 1000 and the Noggin Plus. Fundamentally, the two systems are alike however there are several operational differences. The pE 1000 system is a very flexible instrument in that it allows different antenna separations and orientations, modes of operations, and system parameters to be used. System parameters are input and controlled from a laptop computer. As the data is being collected a profile of the subsurface is displayed on the laptop's screen. Because of its flexibility it takes an experienced operator to use the system effectively. Figure 2 shows the pE 1000 system with the 225 MHz antennas. On the other hand, the cart mounted Noggin Plus is a more user-friendly and straightforward system to operate. The system consists of an antenna and a digital video logger (DVL) all mounted on a cart (Figure 3). Once the unit is unfolded and powered-up, a GPR survey can begin in less than a minute. The DVL is used to input system parameters, collect, display, and store data.

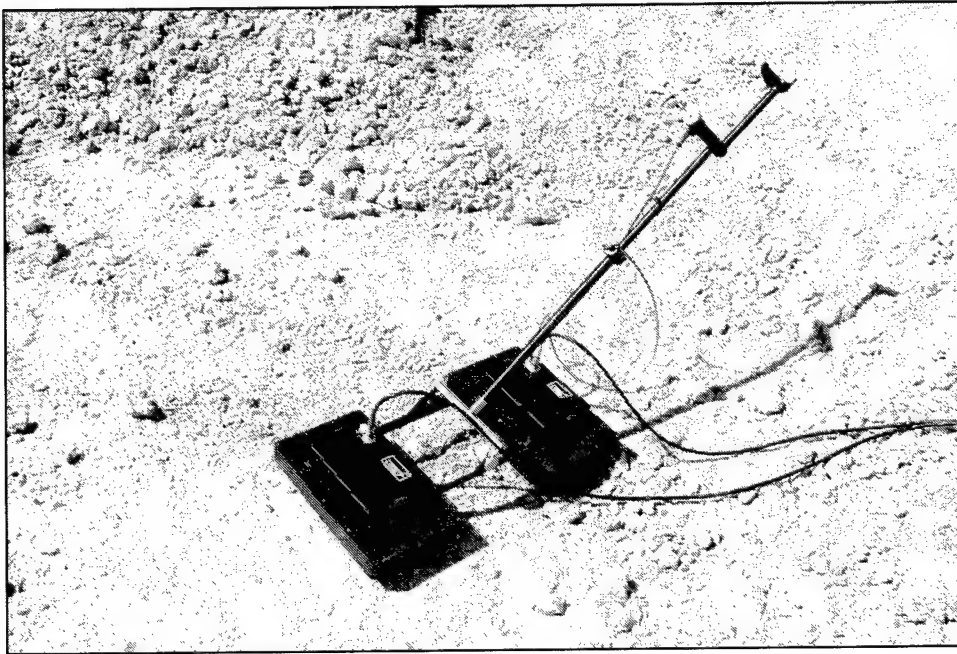


Figure 2. Sensors and Software pE 1000 GPR system with 225 MHz antennas

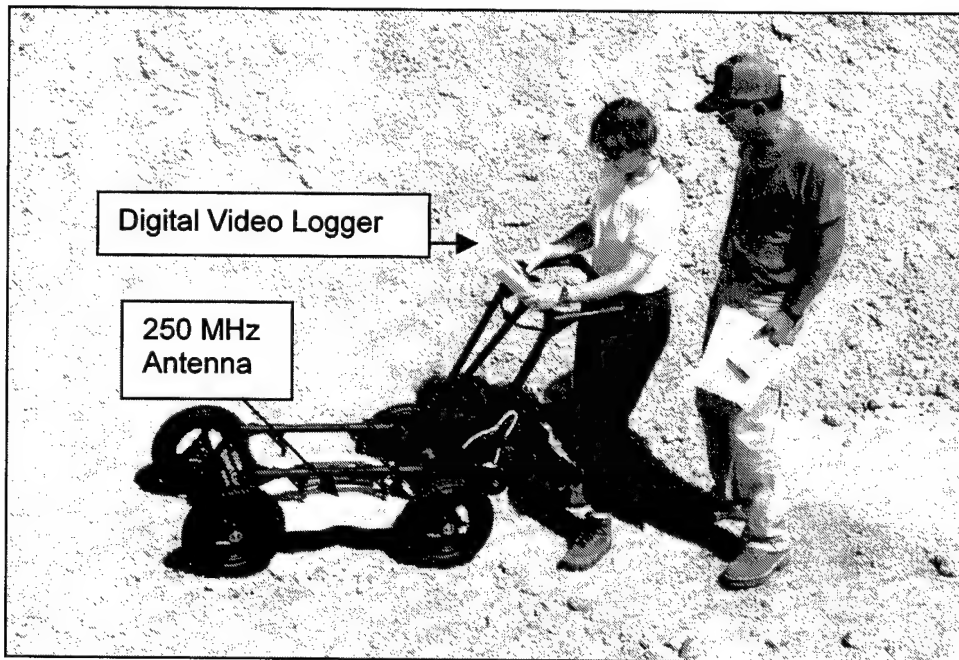


Figure 3. Sensors and Software Noggin Plus Smart Cart system with 250 MHz antenna

## 2 GPR Field Tests

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The GPR surveys were conducted over several different stockpiled materials at the Alabama State Docks, Mobile, AL, and that are typical of cargo carried in the holds of ocean going vessels. Stockpiled materials available at the time of testing were gypsum (crystal form), finely powdered gypsum, crushed pumice, coal, and bauxite.

### Initial Investigations

The objective of the first phase of testing day was to determine the penetrating capabilities of the different antennas in selected stockpiled materials. This was accomplished by burying an object that would reflect EM signals back to the ground surface, in this case a steel pipe 5.1 cm in diameter and 30.5 cm long, in the stockpiles of crystal and powdered gypsum, pumice, and coal. The depths at which the pipe was buried varied between approximately 15 and 32 cm. The surveys were typically conducted by dragging a given radar antenna set on the ground surface along profile lines that were perpendicular to the long axis of the steel pipe. The profile lines were extended beyond the pipe by one or more meters to allow the collection of undisturbed (background) information. Survey lines were run directly over and in some cases off to one or both sides of the pipe. The steel pipe is identifiable in the record as vertically alternating dark and light bands in the shape of a hyperbola as shown in Figure 4.

### Crystal gypsum pile

Figure 5 shows the crystal gypsum pile being prepared for a GPR survey. The material is coarse-grained and has little or no fine-grained material as shown in Figure 6. The steel pipe was laid on the ground surface oriented in a north-south orientation and covered to a depth of approximately 15 cm with gypsum crystals. A sketch of the test layout showing the orientation of the four survey lines relative to the steel pipe is presented is shown in Figure 7. The GPR records of the surveys conducted over the crystal gypsum pile are presented in Appendix A. Table 1 presents the GPR results for the pE1000 and Noggin systems. The pipe was detected with the pE 225 and 450 MHz antennas and with the Noggin system. The depth of penetration in this material is approximately 1 to 1.5 m and is based on the strength of the GPR signal returns seen on the records.

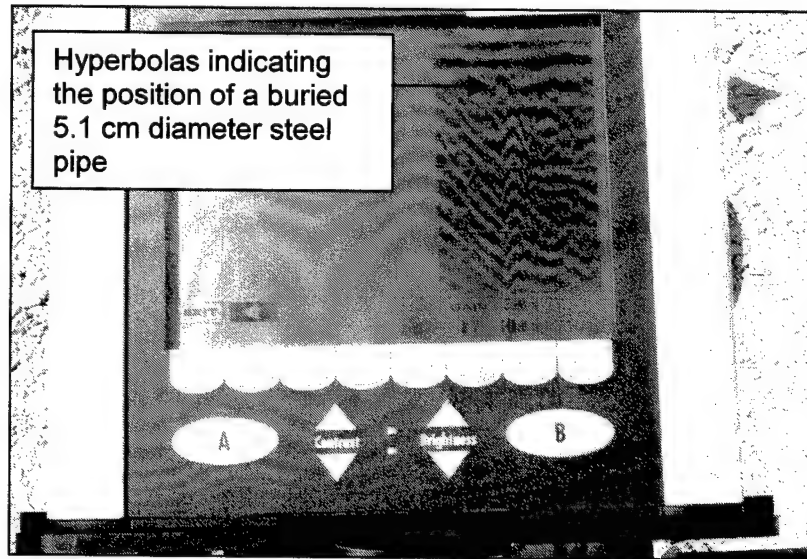


Figure 4. Hyperbolic signature of a 5.1 cm diameter steel pipe buried approximately 15 cm in stockpiled crystal gypsum

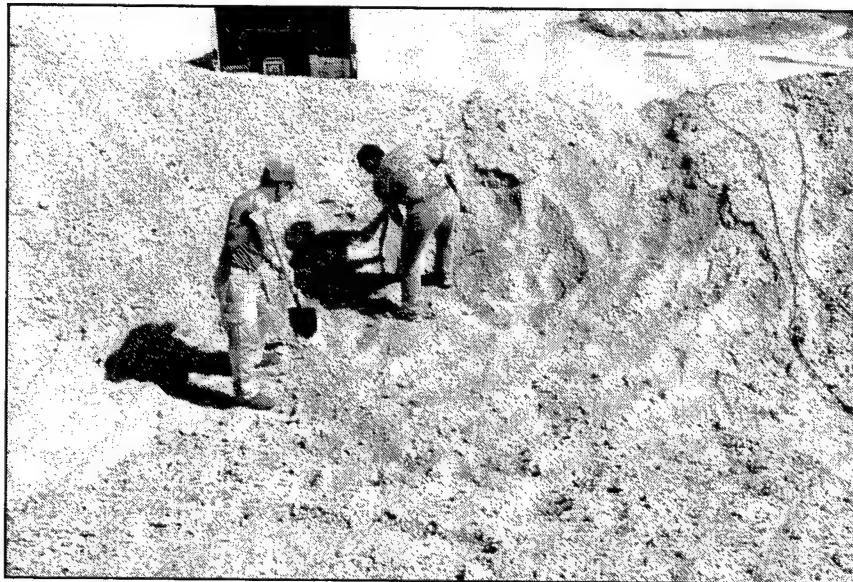


Figure 5. Crystal gypsum pile being prepared for GPR surveying

### **Powdered gypsum pile**

An area near the toe of the powdered gypsum pile was prepared for testing as shown in Figure 8. The material was very fine-grained with the consistency of flour but with some cohesion (Figure 9). A sketch of the test layout is shown in Figure 10. The pipe and a 30 cm long piece of 5.1 cm by 10.2 cm lumber were buried at depths of approximately 20 and 15 cm, respectively. The GPR survey records for the powdered gypsum pile are presented in Appendix B. The

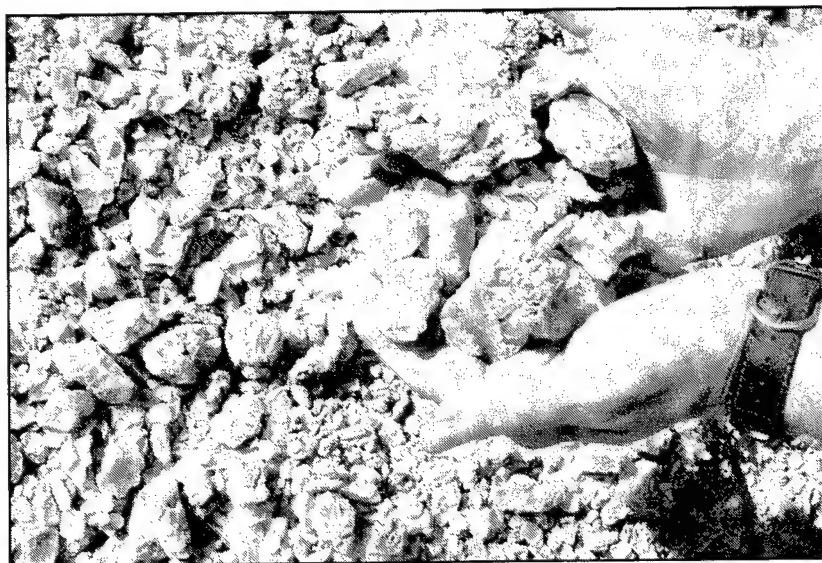


Figure 6. Example of crystal gypsum material showing grain size

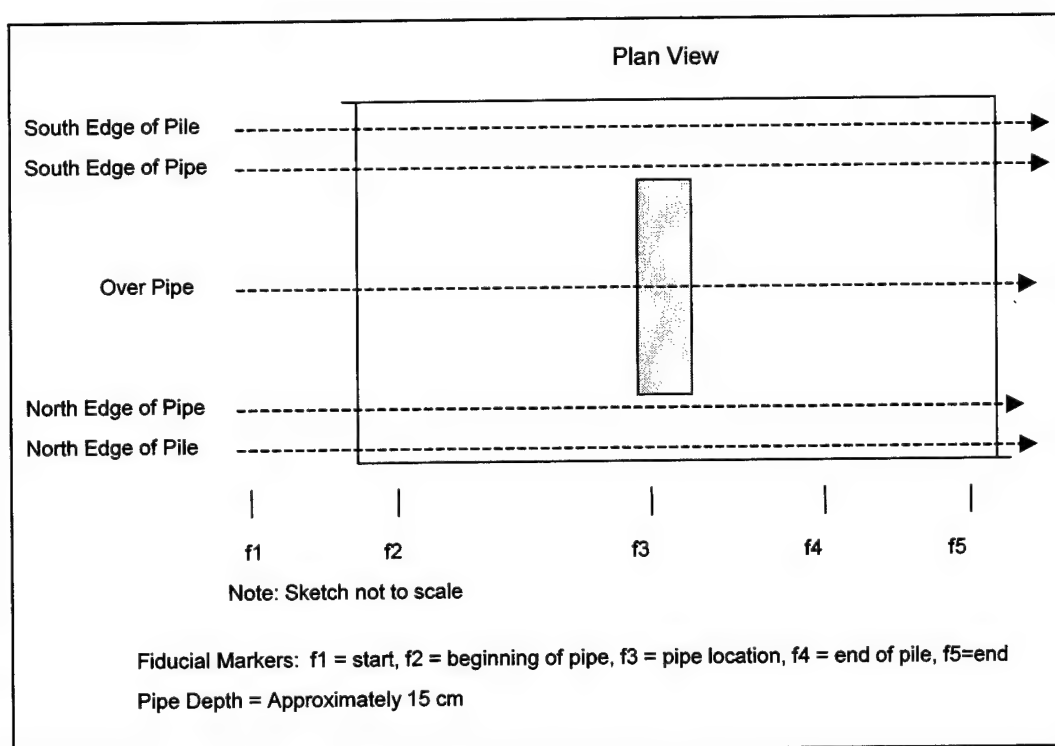


Figure 7. GPR survey line layout, crystal gypsum pile, initial investigation

<b>Table 1 GPR Results, Crystal Gypsum, Initial Investigation</b>				
<b>Antenna Frequency, MHz</b>	<b>System</b>	<b>File Name</b>	<b>Comments</b>	<b>Pipe Detected?</b>
225	pE1000	CG225GP1	North edge of pile off of pipe	No
225	pE1000	CG225GP2	Over pipe	Yes
225	pE1000	CG225GP3	South edge of pipe	Yes
225	pE1000	CG225GP4	South edge of pile off of pipe	No
450	pE1000	CG450GP5	North edge of pile off of pipe	No
450	pE1000	CG450GP6	Over pipe	Yes
450	pE1000	CG450GP7	South edge of pipe	Yes
450	pE1000	CG450GP8	South edge of pile off of pipe	No
900	pE1000	CG900GP1	North edge of pile off of pipe	No
900	pE1000	CG900GP2	Over pipe	No
900	pE1000	CG900GP3	South edge of pipe	No
900	pE1000	CG900GP4	South edge of pile off of pipe	No
250	Noggin	CG250GP0	North edge of pile off of pipe	Yes
250	Noggin	CG250GP1	Over pipe	Yes
250	Noggin	CG250GP3	South edge of pipe	Yes
250	Noggin	CG250GP5	South edge of pile off of pipe	No

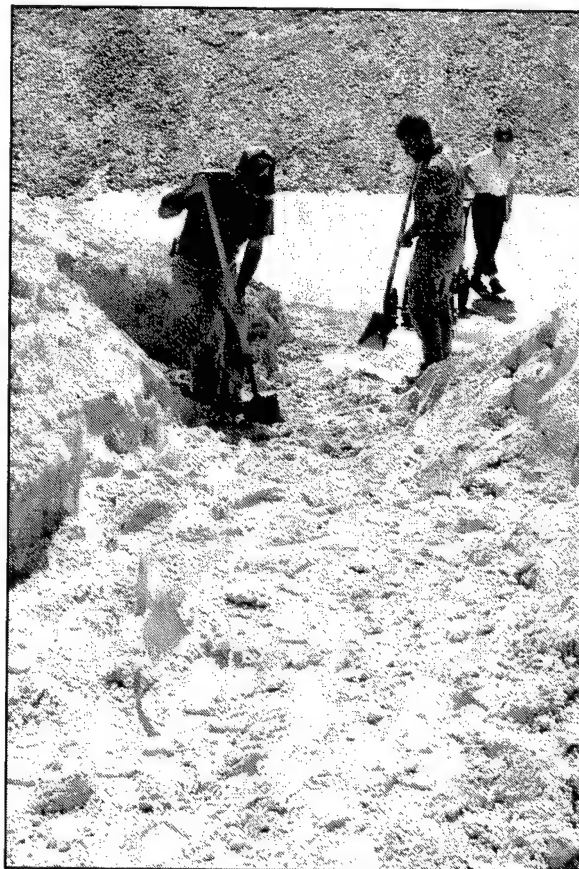


Figure 8. The powdered pumice pile being prepared for GPR surveying





Figure 9. Image showing the fine-grained pumice with apparent cohesion

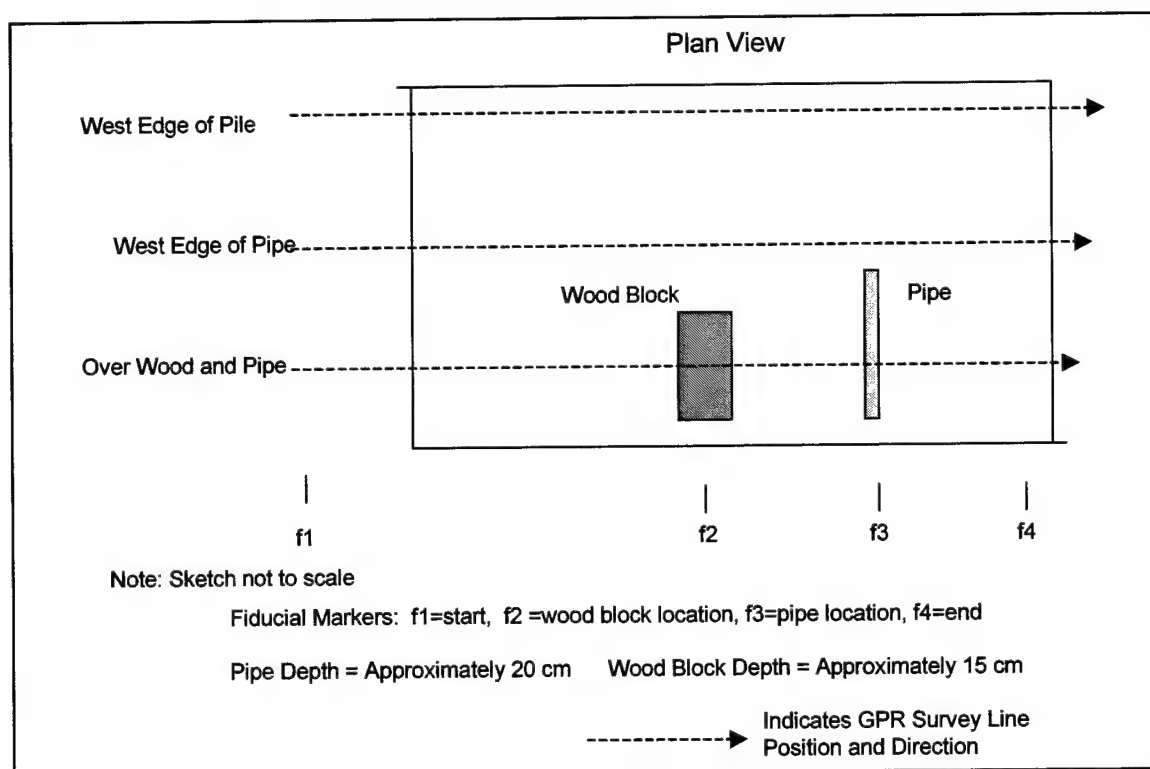


Figure 10. GPR survey layout, powdered gypsum pile, initial investigation



results of the GPR surveys are summarized in Table 2. Based on the strength of the signal returns, both GPR systems have at least a 1 m depth of investigation.

<b>Table 2 GPR Results, Powdered Gypsum, Initial Investigation</b>					
<b>Antenna Frequency, MHz</b>	<b>System</b>	<b>File Name</b>	<b>Comments</b>	<b>Pipe Detected?</b>	<b>Wood Block Detected?</b>
225	pE1000	CG225PP1	West edge of pile	No	No
225	pE1000	CG225PP2	Over pipe	Yes	No
225	pE1000	CG225PP3	Over pipe	Yes	No
450	pE1000	CG450PP1	West edge of pile	No	No
450	pE1000	CG450PP2	Over pipe	No	No
450	pE1000	CG450PP3	Over pipe	No	No
900	pE1000	CG900PP1	West edge of pile	No	No
900	pE1000	CG900PP2	Over pipe	No	No
250	Noggin	CG250PP0	West edge of pile	No	No
250	Noggin	CG250PP1	West edge of pile	Yes	No
250	Noggin	CG250PP2	Over pipe	Yes	Questionable
250	Noggin	CG250PP3	Over pipe	Yes	No

### Crushed pumice pile

The survey lines for the crushed pumice were located at the toe of the pile as shown in Figure 11. The material consists of moderately sorted vesicular fine- to medium-grained pebble gravel in a fine- to medium-grained sand matrix (Figure 12). A sketch of the test layout is shown in Figure 13. The pipe and a 30 cm long piece of 5.1 cm by 10.2 cm lumber were buried at respective depths of approximately 24 and 30 cm. The GPR records for the surveys conducted on the crushed pumice pile are presented in Appendix C. The results of the GPR surveys are summarized in Table 3. The depth of investigation in this material is greater than 3 m.



Figure 11. Location of GPR survey line, crushed pumice pile

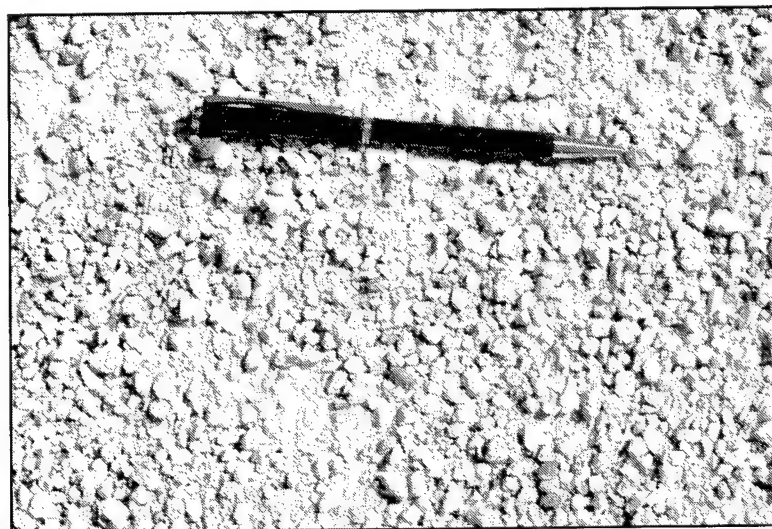


Figure 12. Image illustrating crushed pumice grain size

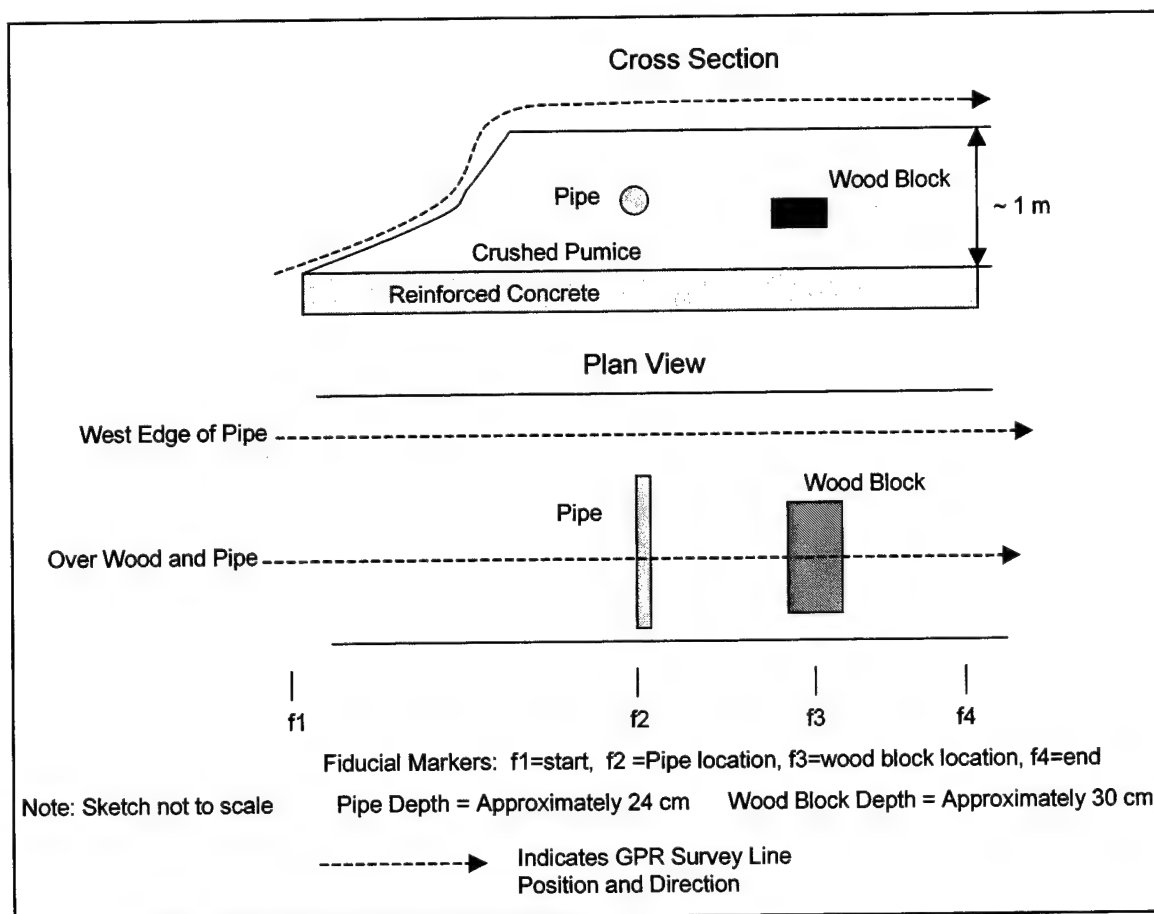


Figure 13. GPR survey layout, crushed pumice pile, initial investigation

<b>Table 3 GPR Results, Crushed Pumice, Initial Investigation</b>					
<b>Antenna frequency, MHz</b>	<b>System</b>	<b>File name</b>	<b>Comments</b>	<b>Pipe detected?</b>	<b>Wood block detected?</b>
225	pE1000	CG225MP1	West edge of pipe	No	No
225	pE1000	CG225MP2	Over pipe	Yes	No
450	pE1000	CG450MP1	West edge of pipe	No	No
450	pE1000	CG450MP2	Over pipe	Yes	No
900	pE1000	CG900MP1	West edge of pipe	No	No
900	pE1000	CG900MP2	Over pipe	No	No
250	Noggin	CG250MP0	West edge of pipe	No	No
250	Noggin	CG250MP1	Over pipe	Yes	No

### Coarse coal pile

The survey lines for the coarse coal pile were located at the toe of the pile as shown in Figure 14. A sketch of the GPR survey layout is presented in Figure 15. The GPR records for the surveys conducted over the coal pile are presented in Appendix D. The results of the GPR surveys are summarized in Table 4. The pipe was difficult to distinguish with the Noggin and not detected with any of the pE antennas. The depth of investigation in this material is at least 1 m.



Figure 14. GPR survey being conducted at the toe of the coarse coal pile with the pE1000 system

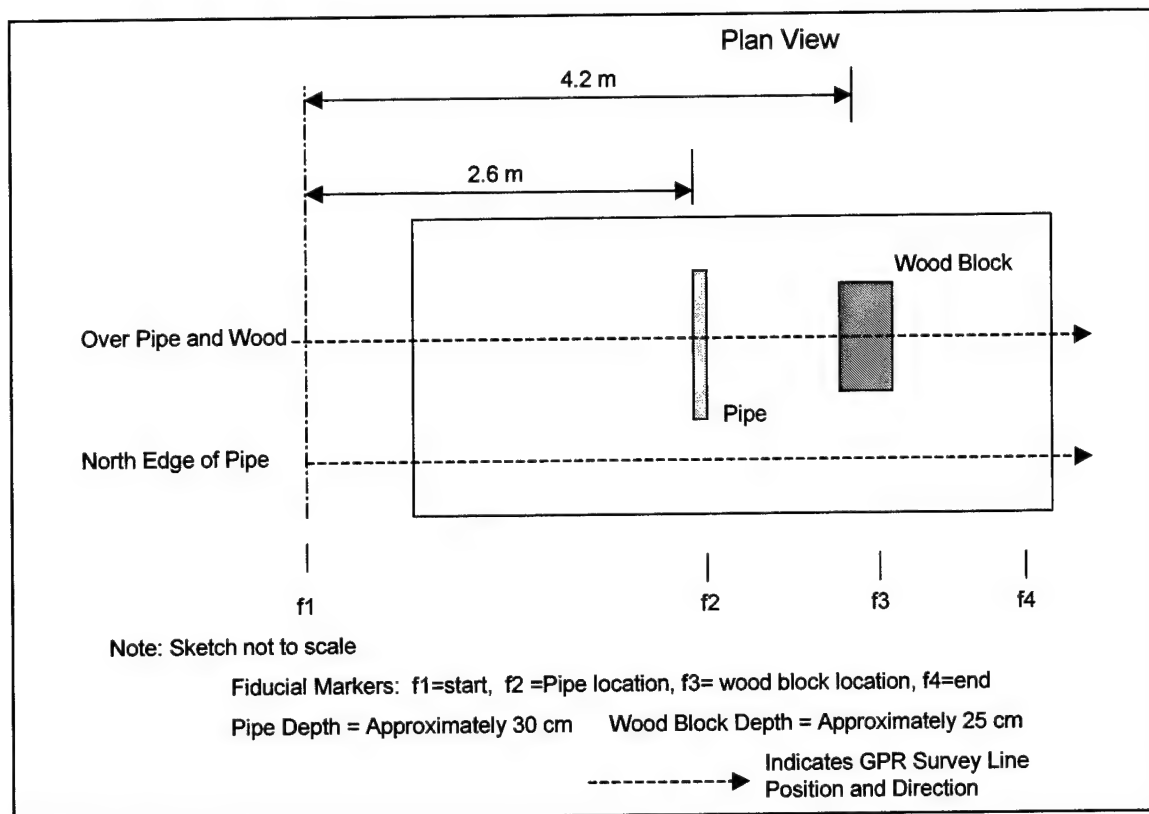


Figure 15. GPR survey line layout, coarse coal pile, initial investigation

Table 4 GPR Results, Coarse Coal, Initial Investigation					
Antenna Frequency, MHz	System	File Name	Comments	Pipe Detected?	Wood Block Detected?
225	pE1000	CG225CP1	North edge of pipe	No	No
225	pE1000	CG225CP2	Over pipe	No	No
450	pE1000	CG450CP1	North edge of pipe	No	No
450	pE1000	CG450CP2	Over pipe	No	No
900	pE1000	CG900CP1	West edge of pipe	No	No
900	pE1000	CG900CP2	Over pipe	No	No
250	Noggin	CG250CP0	North edge of pipe	No	No
250	Noggin	CG250CP1	Over pipe	Yes	Yes
250	Noggin	CG250CP2	Over pipe	Yes	N/A <sup>1</sup>
250	Noggin	CG250CP3	Over pipe	Yes	Yes

<sup>1</sup> GPR survey line did not extend over wood block.

## Buried Contraband Simulant Tests

The second phase of testing consisted of burying contraband simulants in stockpiled materials and determining the ability of GPR in detecting them. The simulant consisted of four 10-lb bags of sugar duct-taped together to form a 40-lb bundle as shown in Figure 16. The sugar bundles were buried in different stockpiled materials at a depth of about 40 cm and GPR profile lines run over the bundles in an attempt to detect the sugar or any evidence of disturbance caused



Figure 16. Two contraband simulants each consisting of four 10-lb bags of sugar duct-taped together

by digging and burying activities. The same GPR systems and antennas used in the first phase of testing were used in the second phase.

### **Crystal gypsum pile**

The site was prepared by placing several lifts of crystal gypsum on the ground surface with a front-end loader to construct an area large enough on which to conduct the GPR surveys (Figure 17). The prepared area measured approximately 10 m long by 5 m wide and varied from about 0.3 to 1 m in height (Figure 18). A 40-lb bundle of sugar was buried near the middle of the prepared area to a depth of approximately 0.4 m and backfilled with crystal gypsum. A sketch of the test area showing the location of the GPR profile lines is presented Figure 19. The GPR records for the surveys conducted over the crystal gypsum are presented in Appendix E. The results of the GPR surveys are summarized in Table 5. The sugar bundle is visible using the Noggin system but is not readily detectable using the pE system.

### **Powdered gypsum pile**

The site was prepared by placing, with a front-end loader, several lifts of powdered gypsum on the ground surface to construct an area large enough on which to conduct the GPR surveys. The prepared area measured approximately 8 m long by 4 m wide by 0.6 m high. Figure 20 shows the prepared tests site.



Figure 17. Contraband simulant being covered with crystal gypsum

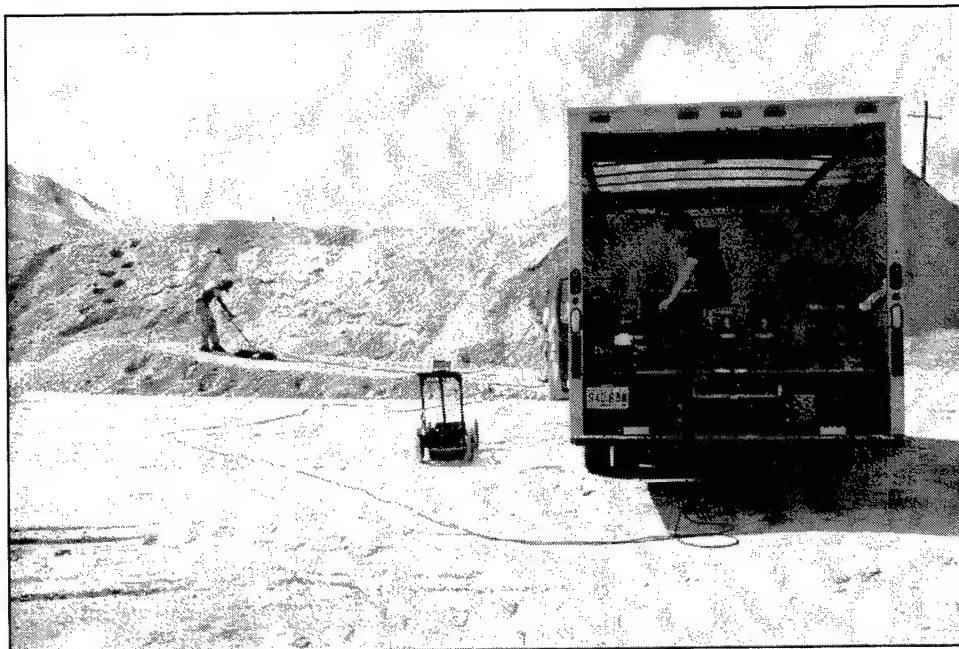


Figure 18. GPR survey being conducted over prepared crystal gypsum site

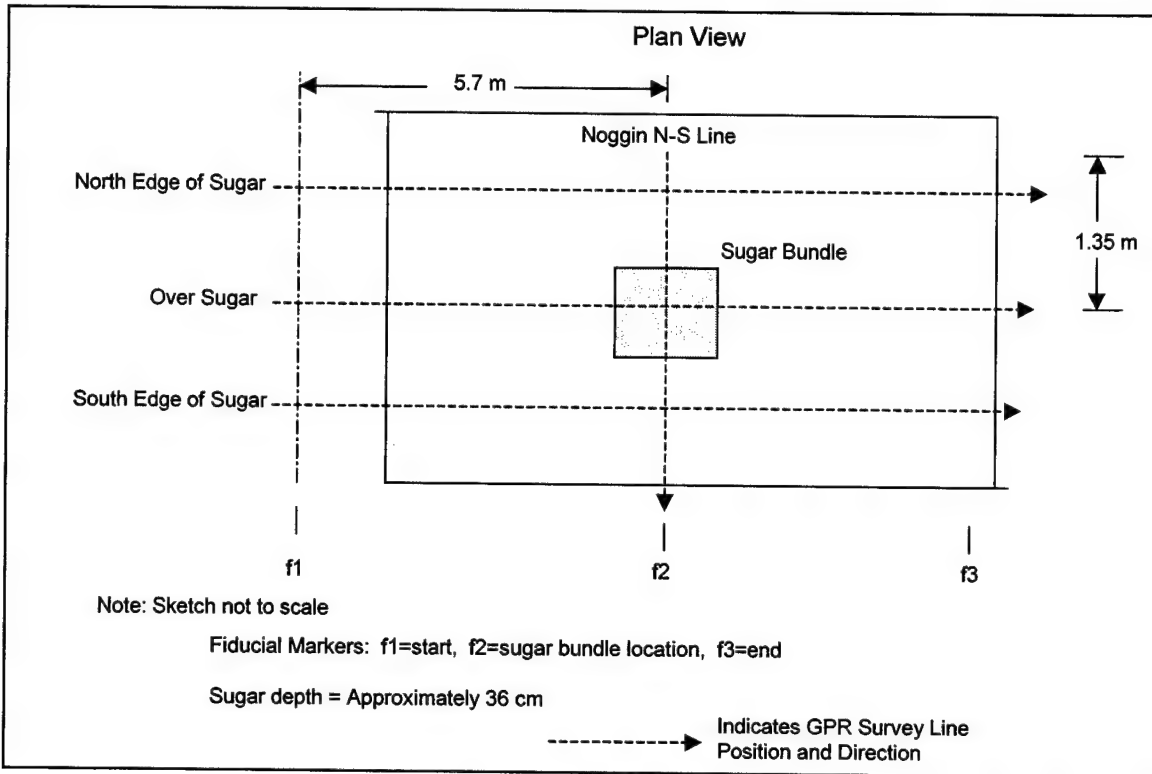


Figure 19. GPR survey line layout, crystal gypsum pile, buried contraband simulant tests

<b>Table 5</b>				
<b>GPR Results, Crystal Gypsum, Buried Contraband Simulant Tests</b>				
<b>Antenna Frequency, MHz</b>	<b>System</b>	<b>File Name</b>	<b>Comments</b>	<b>Simulant Detected?</b>
225	pE1000	CG225GS	North of sugar	No
225	pE1000	CG225GS2	North of sugar	No
225	pE1000	CG225GS3	Over sugar	No
225	pE1000	CG225GS4	Over sugar	No
225	pE1000	CG225GS5	South of sugar	No
450	pE1000	CG450GS1	North of sugar	No
450	pE1000	CG450GS2	Over sugar	No
450	pE1000	CG450GS3	South of sugar	No
900	pE1000	CG900GS1	North of sugar	No
900	pE1000	CG900GS2	Over sugar	No
900	pE1000	CG900GS3	South of sugar	No
250	Noggin	CG250GS0	North of sugar	Questionable
250	Noggin	CG250GS1	Over sugar	Yes
250	Noggin	CG250GS2	Over sugar	Yes
250	Noggin	CG250GS3	South edge of pile off of pipe	No
250	Noggin	CG250GS4	Over sugar (N-S line orientation)	Yes



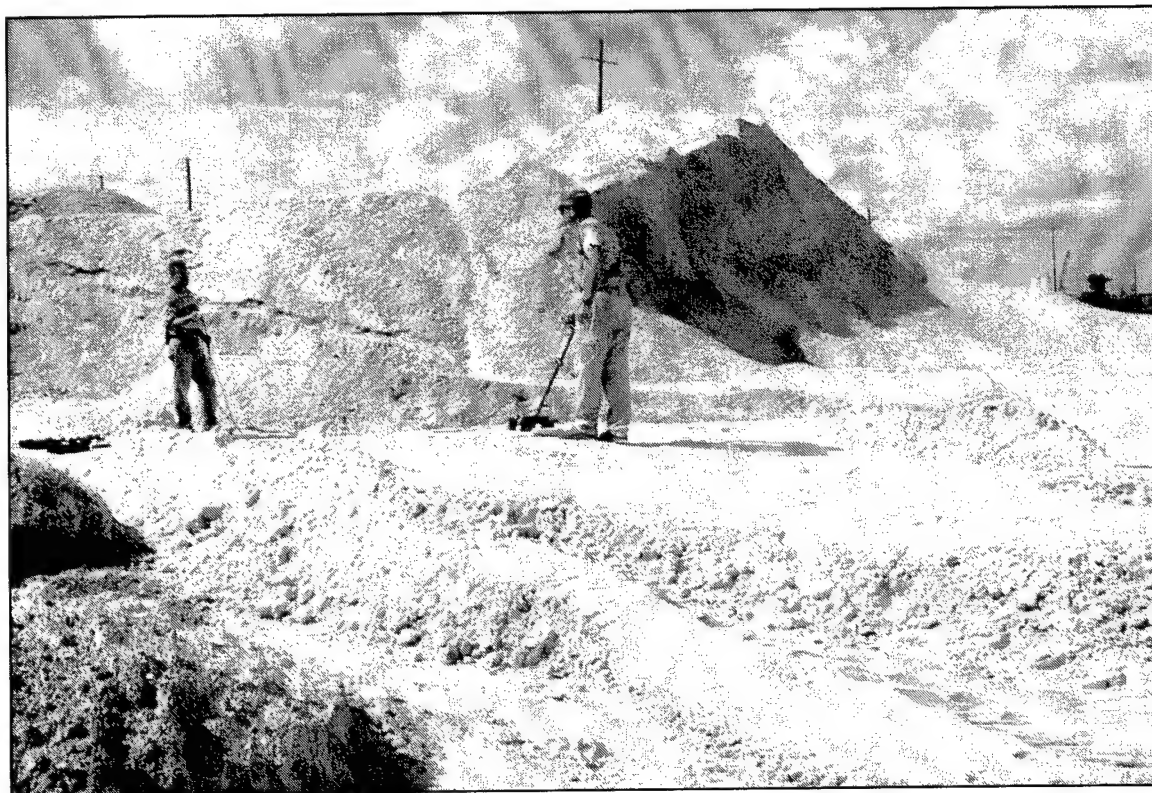


Figure 20. Powdered gypsum test site, buried simulant test

The bundle of sugar was buried near the middle of the prepared area to a depth of approximately 0.4 m and backfilled with powdered gypsum. The steel pipe was buried to a depth of approximately 25 cm near the sugar bundle as shown in Figure 21. The GPR records for the surveys conducted over the powdered gypsum are presented in Appendix F. The results of the GPR surveys are summarized in Table 6. The pE 225 MHz antenna and the Noggin system are able to locate the sugar bundle. The pipe was buried after the Noggin and prior to the pE systems being run over the site.

### **Crushed pumice pile**

Testing was conducted on the same narrow ridge of pumice on the toe of the pumice pile as was used for locating the pipe in the initial investigations as shown in Figure 22. The 40-lb bundle of sugar was buried to a depth of 40 cm and backfilled with crushed pumice. All of the GPR profile lines were run over the buried sugar because of the limited testing area. A sketch of the test area showing the location of the GPR profile lines is presented Figure 23. The GPR records for the surveys conducted over the crushed pumice are presented in Appendix G. The results of the GPR surveys conducted over the crushed pumice are summarized in Table 7. The sugar bundle or soil disturbance can be detected using the Noggin and pE 225 and 450 MHz.



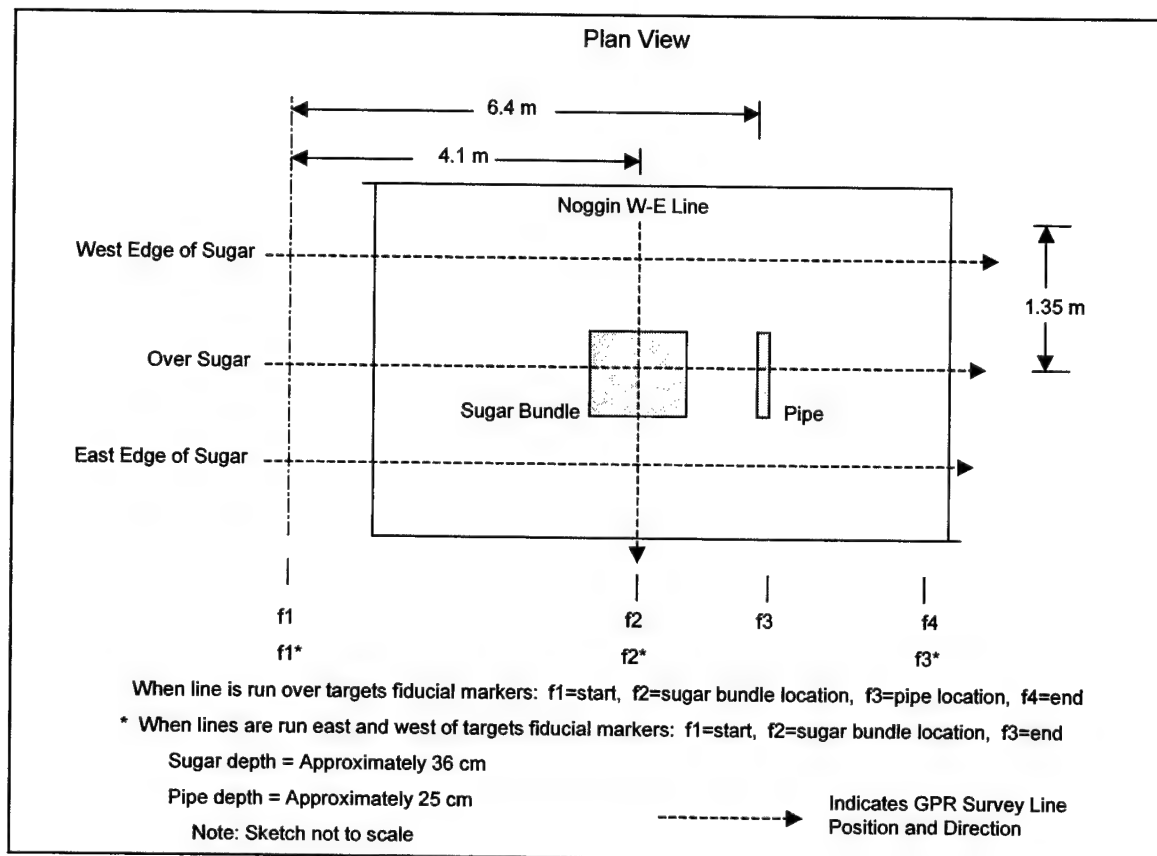


Figure 21. GPR survey line layout, powdered gypsum pile, buried contraband simulant test

<b>Table 6</b> <b>GPR Results, Powdered Gypsum, Buried Contraband Simulant Tests</b>					
Antenna Frequency, MHz	System	File Name	Comments	Simulant Detected?	Pipe Detected?
225	pE1000	CG225PS1	West of sugar	No	No
225	pE1000	CG225PS2	Over sugar	Yes	Yes
225	pE1000	CG225PS3	Over sugar	Yes	Yes
225	pE1000	CG225PS4	East of sugar	No	No
450	pE1000	CG450PS1	West of sugar	No	No
450	pE1000	CG450PS2	Over sugar	No	No
450	pE1000	CG450PS3	Over sugar	No	No
450	pE1000	CG450PS4	East of sugar	No	No
900	pE1000	CG900PS1	West of sugar	No	No
900	pE1000	CG900PS2	Over sugar	No	No
900	pE1000	CG900PS3	Over sugar	No	No
900	pE1000	CG900PS4	East of sugar	No	No
250	Noggin	CG250PS0	West of sugar	Yes	N/A <sup>1</sup>
250	Noggin	CG250PS1	Over sugar	Yes	N/A <sup>1</sup>
250	Noggin	CG250PS2	Over sugar	Yes	N/A <sup>1</sup>
250	Noggin	CG250PS3	East edge of pile off of pipe	No	N/A <sup>1</sup>
250	Noggin	CG250PS4	Over sugar (W-E line orientation)	Yes	N/A <sup>1</sup>

<sup>1</sup>Note: The pipe was not in-place during the Noggin system surveys.



Figure 22. pulseEKKO 1000 GPR survey over simulated contraband, crushed pumice

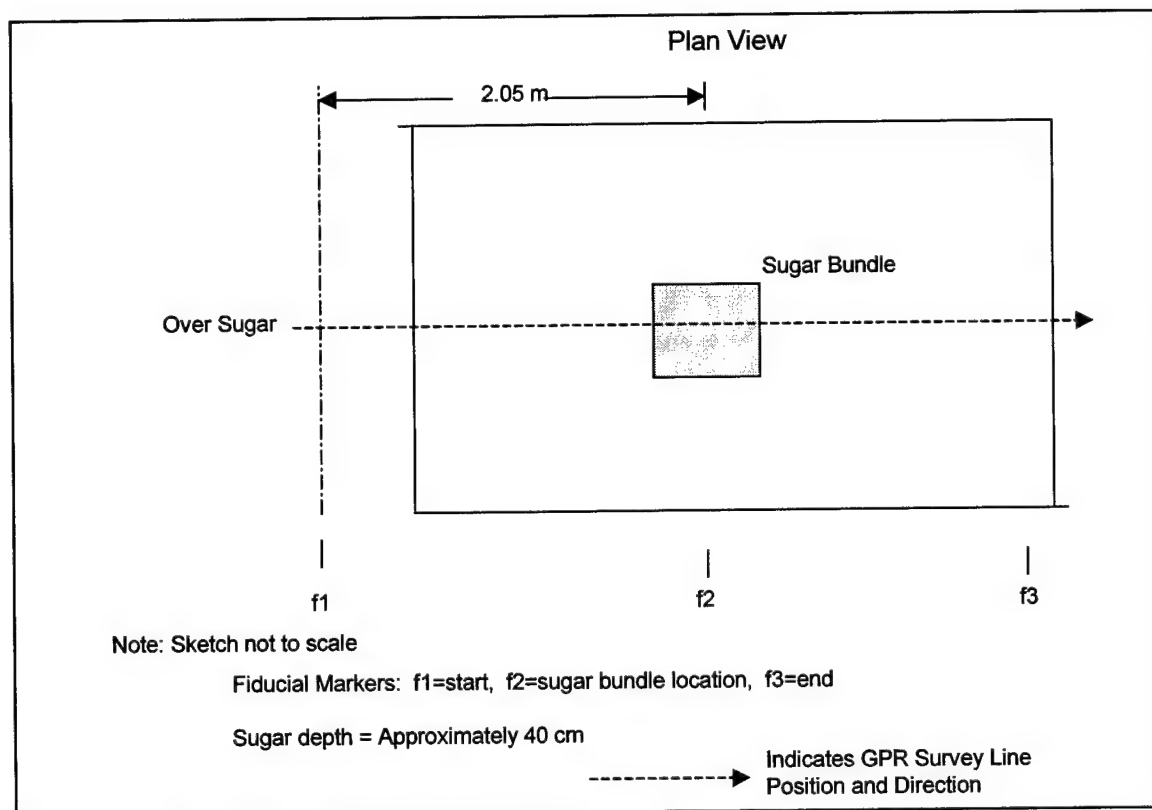


Figure 23. GPR survey line layout, crushed pumice pile, buried contraband simulant test

<b>Table 7</b> <b>GPR Results, Crushed Pumice, Buried Contraband Simulant Tests</b>				
<b>Antenna Frequency, MHz</b>	<b>System</b>	<b>File Name</b>	<b>Comments</b>	<b>Simulant Detected?</b>
225	pE1000	CG225MS1	Over sugar	Yes
225	pE1000	CG225MS2	Over sugar	Yes
450	pE1000	CG450MS1	Over sugar	No
450	pE1000	CG450MS2	Over sugar	No
900	pE1000	CG900MS1	Over sugar	No
900	pE1000	CG900MS2	Over sugar	No
250	Noggin	CG250MS0	Over sugar	Yes
250	Noggin	CG250MS1	Over sugar	Yes

### **Bauxite pile**

GPR tests were conducted along a 6-m-long track on the slope of a large bauxite pile as shown in Figure 24. The bauxite pile was not initially tested using a buried pipe, as was the case with the gypsum and pumice piles because this was an area with heavy truck traffic and access to the pile was limited to after regular work hours. Two holes were dug into the bauxite pile. The holes, one located 2.5 m from the survey start, was used to bury a 40-lb bundle of sugar and the other hole, located 4.1 m from the start, a steel pipe that measured 5.1 cm in diameter and 30.5 cm long. A sketch of the test area showing the location of the GPR profile lines is presented Figure 25. The GPR records for the surveys conducted over the bauxite pile are presented in Appendix H. The results of the GPR surveys conducted over the crushed pumice are summarized in Table 8. The buried steel pipe appears as a hyperbola and is easy to discern in the records of all the frequencies. Without prior knowledge of the location of the sugar bundle it would be difficult to distinguish its location in the GPR records. The sugar bundle signature can be seen in all of the records and is most clearly seen in the 450 MHz records, especially record CG450BS2.

### **Coal pile**

GPR testing was conducted along an area just above the toe of a large pile of crushed coal (Figure 26). This coal pile was different than the one used for the initial buried pipe test. The coal in this pile was finer grained and in a looser density state because it had been recently been offloaded whereas the coal pile used in the initial investigations was coarser grained and the pile appeared to have been in place for months if not years. Two holes were dug into the coal pile. The holes, one located 2.2 m from the survey start, was used to bury a 40-lb bundle of sugar and the other hole, located 3.9 m from the start, a steel pipe that measured 5.1 cm in diameter and 30.5 cm long. The bundle of sugar and the steel pipe were buried at a depth of 0.35 m. A sketch of the test area showing the location of the GPR profile lines is presented Figure 27. The GPR records for the surveys conducted over the coal pile are presented in Appendix I. The results of the GPR surveys conducted over the coal are summarized in Table 9. The pipe is detected with all of the antennas. The higher frequency antennas provide greater resolution. The bundle of sugar is only detectable with the 450 and 900 MHz antennas.



Figure 24. Noggin GPR survey over simulated contraband, bauxite pile

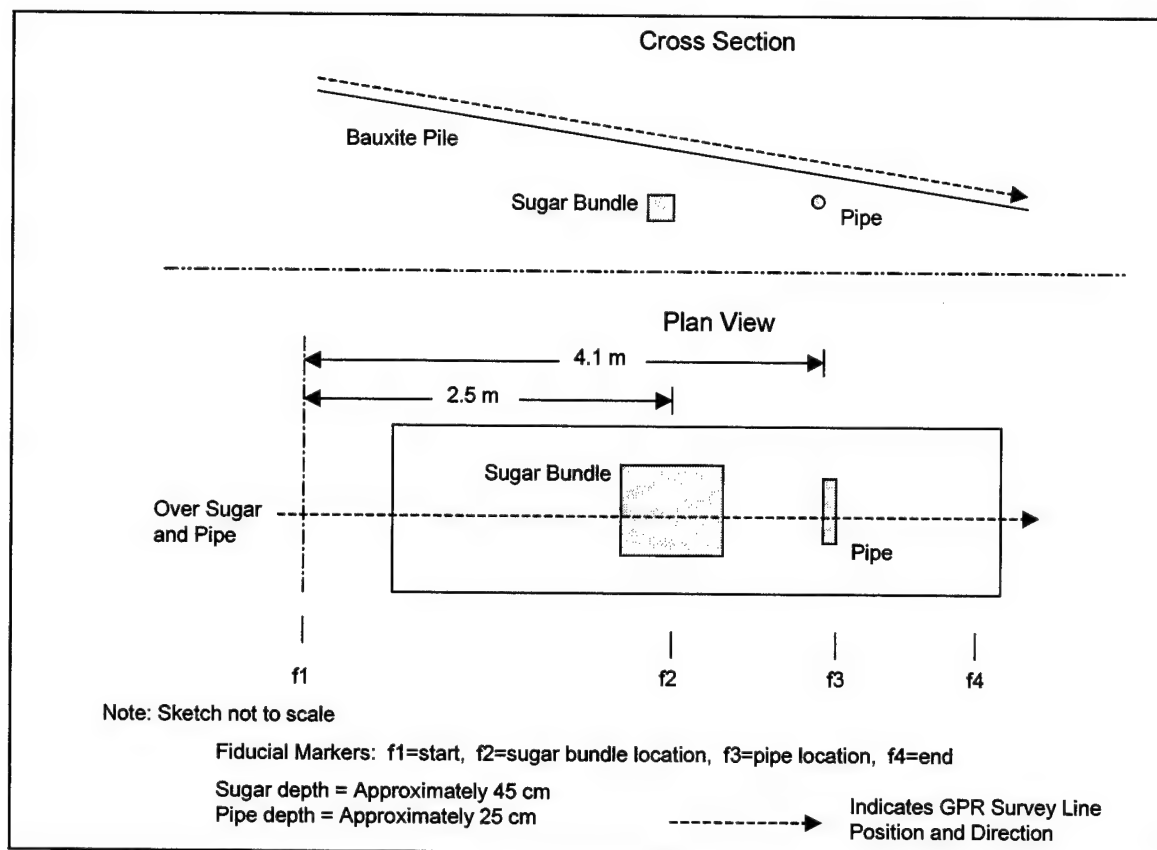


Figure 25. GPR survey line layout, bauxite pile, buried contraband simulant test

<b>Table 8</b> <b>GPR Results, Bauxite, Buried Contraband Simulant Tests</b>					
Antenna Frequency, MHz	System	File Name	Comments	Simulant Detected?	Pipe Detected?
225	pE1000	CG225BS1	Over sugar	Yes	Yes
225	pE1000	CG225BS2	Over sugar	Yes	Yes
450	pE1000	CG450BS1	Over sugar	Yes	Yes
450	pE1000	CG450BS2	Over sugar	Yes	Yes
900	pE1000	CG900BS1	Over sugar	Questionable	Yes
900	pE1000	CG900BS2	Over sugar	Questionable	Yes
250	Noggin	CG250BS0	Over sugar	Yes	Yes
250	Noggin	CG250BS1	Over sugar	Yes	Yes

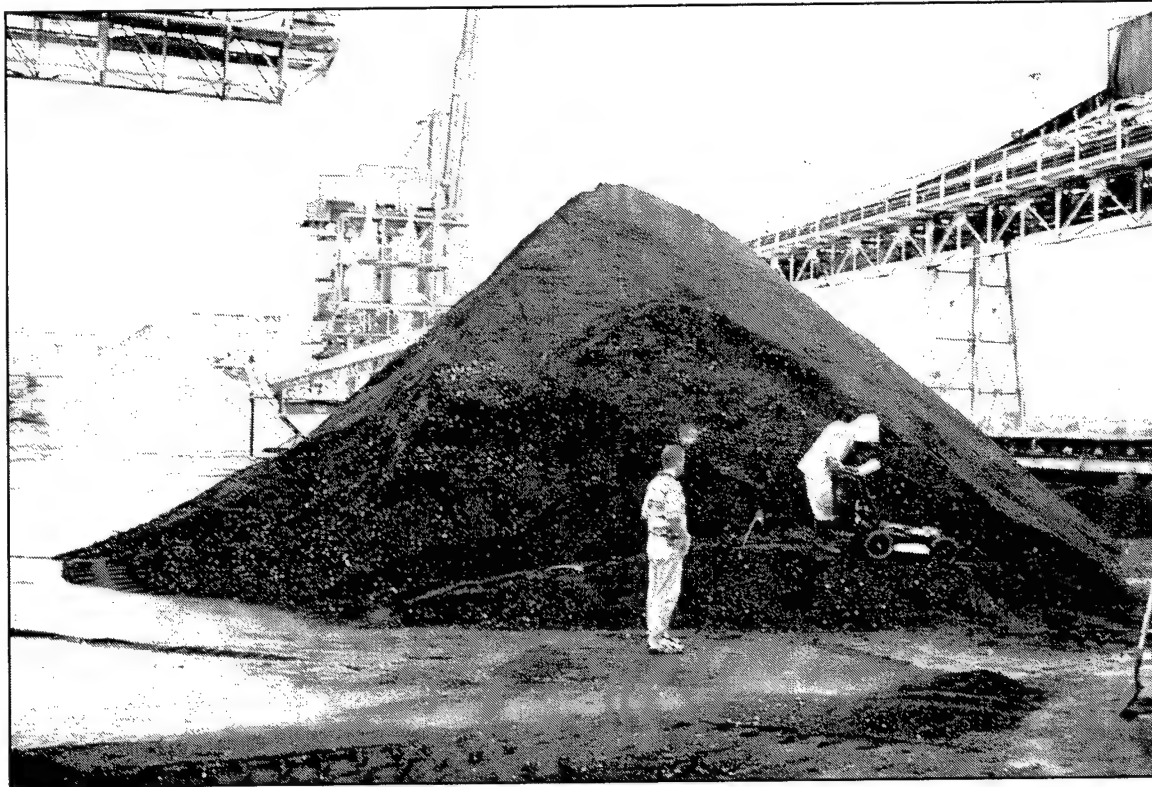


Figure 26. Noggin GPR survey over simulated contraband, coal pile

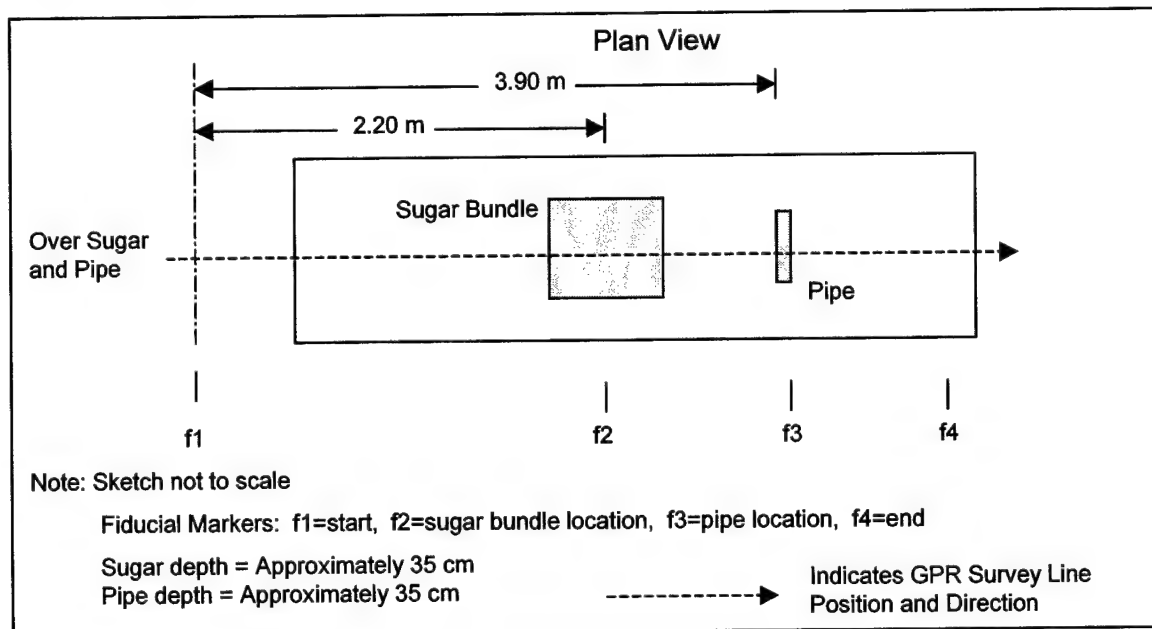


Figure 27. GPR survey line layout, coal pile, buried contraband simulant test

<b>Table 9 GPR Results, Coal, Buried Contraband Simulant Tests</b>					
<b>Antenna Frequency, MHz</b>	<b>System</b>	<b>File Name</b>	<b>Comments</b>	<b>Simulant Detected?</b>	<b>Pipe Detected?</b>
225	pE1000	CG225LS1	Over sugar	No	Yes
225	pE1000	CG225LS2	Over sugar	No	Yes
450	pE1000	CG450LS1	Over sugar	Yes	Yes
450	pE1000	CG450LS2	Over sugar	Yes	Yes
900	pE1000	CG900LS1	Over sugar	Yes	Yes
900	pE1000	CG900LS2	Over sugar	Yes	Yes
250	Noggin	CG250LS0	Over sugar	No	Yes
250	Noggin	CG250LS1	Over sugar	No	Yes

## Terrain Conductivity Tests

In addition to the GPR surveys, conductivity surveys were also conducted over the various test materials. The conductivity measurements were collected to determine if there was a correlation of conductivity to GPR depth of penetration or detection capability. A Geonics Ltd. EM38 terrain conductivity meter was used to collect the conductivity measurements (Figure 28). The measurements for the crystal and powdered gypsum and pumice were collected along the GPR survey lines used for the buried sugar experiments. The EM surveys were conducted by placing the meter in direct contact with the material and taking measurements every 0.5 m along the survey line. During the surveys it was noticed that the EM values for these materials were quite high. It was suspected that the metal rebar in the reinforced concrete slabs upon which the crystal and powdered gypsum, crushed pumice, and coarse coal piles are placed were affecting the conductivity readings. Spot conductivity measurements were taken at different elevations on the piles to collect readings not influenced by the metal rebar. Table 10 summarizes the conductivity values in millisiemens per meter (mS/m) for all the piles tested with the exception of the fine coal pile. Because of truck loading operations taking place by the fine coal pile, conductivity measurements were not taken. It is noted that, with the exception of the bauxite pile, the conductivity values taken along the GPR lines are significantly higher than those taken near the top of respective piles.

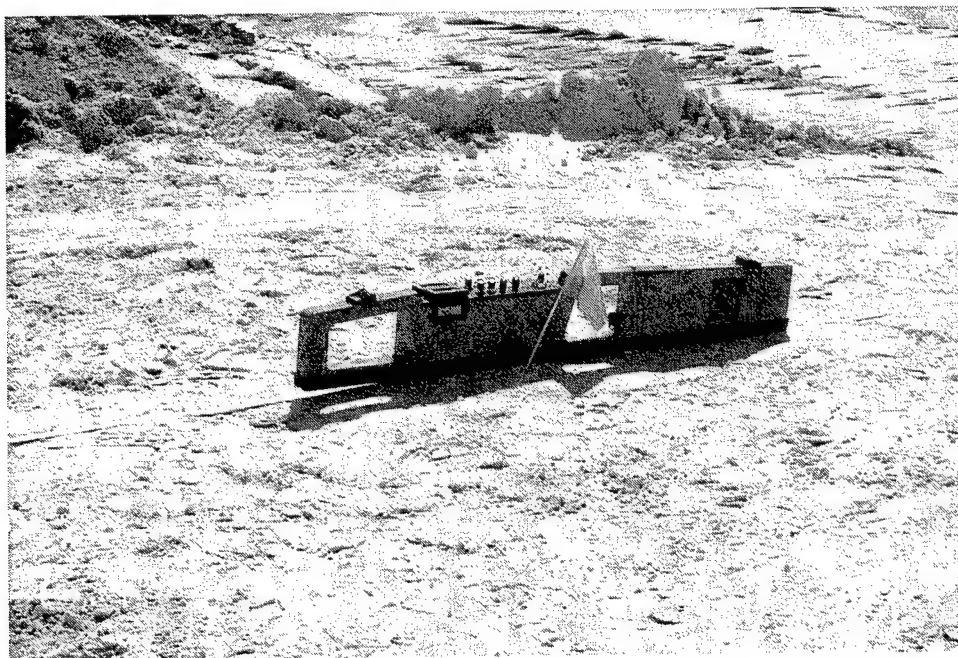


Figure 28. Geonics Ltd. EM38 terrain conductivity meter

<b>Table 10</b>		
<b>Conductivity Values for Different Test Pile Materials</b>		
<b>Material Type</b>	<b>Range and Average Conductivity Values Along GPR Profile Line, mS/m</b>	<b>Conductivity Range on Pile, mS/m</b>
Crystal gypsum	Range = 44-83 Average = 70	5-20; top of pile
Powdered gypsum	Range = 65-91 Average = 77	9-16; top of pile
Pumice	Range = 66-166 Average = 105	29-40; ½ way up pile 15; ¾ way up pile 8; top of pile
Coal (coarse)	Range = 110-140 Average = 125	85-128; ½ way up pile 63-84; ¾ way up pile
Bauxite	Range = 17-45 Average = 35	12-28; ½ way up pile



### 3 Discussion of Results

Ground penetrating radar surveys were run over several stockpiled materials to determine the effectiveness of GPR in detecting buried contraband material. Several items types were buried in the stockpiled materials and GPR surveys run over them to determine which antennas were the most effective in detecting the items in specific materials. The buried items consisted of a pipe, a block of wood, and bundled together bags of sugar. Table 11 summarizes the ability of the tested GPR antennas in detecting the buried objects in the different stockpiled materials. Table 11 pertains to surveys conducted directly over the buried items.

<b>Table 11</b>							
<b>Buried Items Detected with GPR Surveys in Different Stockpiled Materials</b>							
<b>Antenna Frequency, MHz</b>	<b>Buried Item</b>	<b>Buried Item Detected in Stockpiled Material? Yes/No</b>					
		<b>Crystal Gypsum</b>	<b>Powdered Gypsum</b>	<b>Crushed Pumice</b>	<b>Coarse Coal</b>	<b>Bauxite</b>	<b>Coal</b>
225	Steel Pipe	Yes	Yes	Yes	No	Yes	Yes
450	Steel Pipe	Yes	No	Yes	No	Yes	Yes
900	Steel Pipe	No	No	No	No	Yes	Yes
250 <sup>1</sup>	Steel Pipe	Yes	Yes	Yes	Yes	Yes	Yes
225	Wood Block	N/A	No	No	No	N/A	N/A
450	Wood Block	N/A	No	No	No	N/A	N/A
900	Wood Block	N/A	No	No	No	N/A	N/A
250 <sup>1</sup>	Wood Block	N/A	?	No	Yes	N/A	N/A
225	Sugar Bundle	No	Yes	Yes	N/A	Yes	No
450	Sugar Bundle	No	No	No	N/A	Yes	Yes
900	Sugar Bundle	No	No	No	N/A	?	Yes
250 <sup>1</sup>	Sugar Bundle	Yes	Yes	Yes	N/A	Yes	No

<sup>1</sup>Denotes Noggin Plus System.

Referring to Table 11 it is seen that the GPR antennas perform differently in detecting the different buried objects in the various stockpiled materials. Table 12 shows the ability of the different antennas in detecting the steel pipe, wood block, and sugar bundle in the stockpiled materials.

Referring to Table 12 the steel pipe was the most readily detected object, as expected, and the wood block the most difficult. The 250 MHz antenna was the only antenna capable of detecting the wood block. In general, the 250 MHz antenna was the most effective antenna for detecting the buried items followed by, in the order of most effective in detecting the buried targets, the 225, 450,

**Table 12**  
**GPR Detection Capability for a Steel Pipe, Wood Block, and Sugar Bundle in Stockpiled Materials**

Antenna Frequency, MHz	Percent Detection		
	Steel Pipe	Wood Block	Sugar Bundle
225	83	0	60
450	67	0	40
900	33	0	20
250*	100	33	80

\* Denotes Noggin Plus System.

and 900 MHz antennas. The wood block was detected in the coarse coal and it is questionable whether it was detected in the powdered gypsum with the 250 MHz antenna.

With the exception of the initial tests conducted on the coarse gypsum pile, the GPR surveys were run over test sites prepared by placing relatively thin layers (1-2 m) of stockpiled material on the ground surface. Because of the relative thinness of the prepared test site and since many of the tests were conducted on reinforced concrete pads, a very good EM energy reflector, it is difficult to determine the maximum depth of penetration of the GPR for the various stockpiled materials. The survey records indicate that the GPR was able to penetrate through the entire thickness of all the tested materials to the top of the reinforced concrete. In order to determine the maximum depth of penetration in each of the materials GPR surveys would have to be conducted over increasing amounts of material until the reflecting concrete surface was no longer visible in the records.

## 4 Summary and Conclusions

---

Ground penetrating radar (GPR) surveys were conducted over various stockpiled materials at the Alabama State Docks located in Mobile, AL. The surveys were conducted to determine whether GPR is a viable method for rapidly detecting contraband materials buried in the cargo holds of ocean going vessels. The surveys were conducted by burying a steel pipe, a wood block, and a contraband simulant (a bundle of four 10-lb bags of sugar duct-taped together) in stockpiled materials available on site. The different materials reflect different amounts of radar energy back to the surface. The steel pipe was used because metal objects reflect one hundred percent of the radar energy that strikes it and should provide the easiest target to locate whereas, the wood block and sugar bundle, which were used as a more realistic target, reflect only a fraction of the radar energy that strikes them and therefore should be a more difficult target to detect. The materials tested were; gypsum crystal, powdered gypsum, crushed pumice, coarse coal, fine coal, and bauxite.

Two GPR systems manufactured by Sensors & Software, Inc, were used to conduct the surveys. The first system, the pulseEKKO 1000 system, was used with 225, 450, and 900 MHz antennas. The Noggin Plus was the second system used and it employed a 250 MHz antenna. Different frequency antennas were used to obtain different penetration depths and target resolution. The lower the GPR's antenna frequency the deeper it can search but less able it is to resolve smaller targets. High frequency GPR antennas cannot search as deep as the low frequency antennas but provide better definition of small buried targets within their search range. Therefore there is a trade-off between the search depth and the ability to resolve a target.

All of the antennas tested were successful in detecting the location of the contraband simulant in at least one of the stockpiled materials. The 225 and 250 MHz antennas had the highest percent of detecting the simulant in the stockpiled materials (40 and 80 percent, respectively) whereas the 900 MHz antenna had the lowest (20 percent). All of the antennas tested have penetration depths of greater than 1.5 m. Because of the way the test sections were configured the maximum depth of penetration for the antennas was not obtained.

Terrain conductivity values were collected for all the materials except for the fine coal pile. The conductivity values were taken to determine the effect of conductivity on the GPR's depth of penetration. In general, the lower the conductivity the greater the GPR depth of penetration. Since the maximum depth of

penetration could not be determined from the GPR surveys no correlation between conductivity values and penetration depth could be made.

The GPR surveys run on the different stockpiled materials at the Alabama State Docks demonstrate that GPR is a feasible means of locating contraband buried to depths of at least 1 to 2 m on ocean going vessels. However, the success of GPR in locating contraband material depends on the size of the target and the material in which it is hidden. The performance of GPR in different materials is dependent on the material's magnetic and electrical properties and therefore difficult to assess prior to deployment.

It is recommended that the U.S. Coast Guard consider using GPR for detecting contraband in the cargo holds of ships. It is also recommended that future GPR surveys be conducted using the Noggin system for the following reasons: (1) the Noggin system with the 250 MHz antenna performed better than the pE1000 system in detecting the sugar bundles, (2) it is easy to set-up, operate, and is fairly portable, (3) the antennas are shielded which means that the data would not be affected by reflections from overhead or nearby surfaces, (4) the antenna can be detached from the cart system to survey in tight areas, and (5) the system has a real-time display that is easy to read and interpret. An interchangeable 500 MHz antenna that may provide greater resolution is also available for the Noggin system.

Since it has been shown that GPR can be used in locating contraband simulants in various stockpiled materials under fairly ideal conditions the next step is to determine how it would perform under more realistic conditions such as those encountered aboard a ship. It is proposed that the Noggin system with the 250 and 500 MHz antennas be tested aboard a ship to assess its capabilities to detect buried simulants and also to assess any system deficiencies or problems, such as equipment portability, access issues, and potential sources of interference that may be affect the GPR.

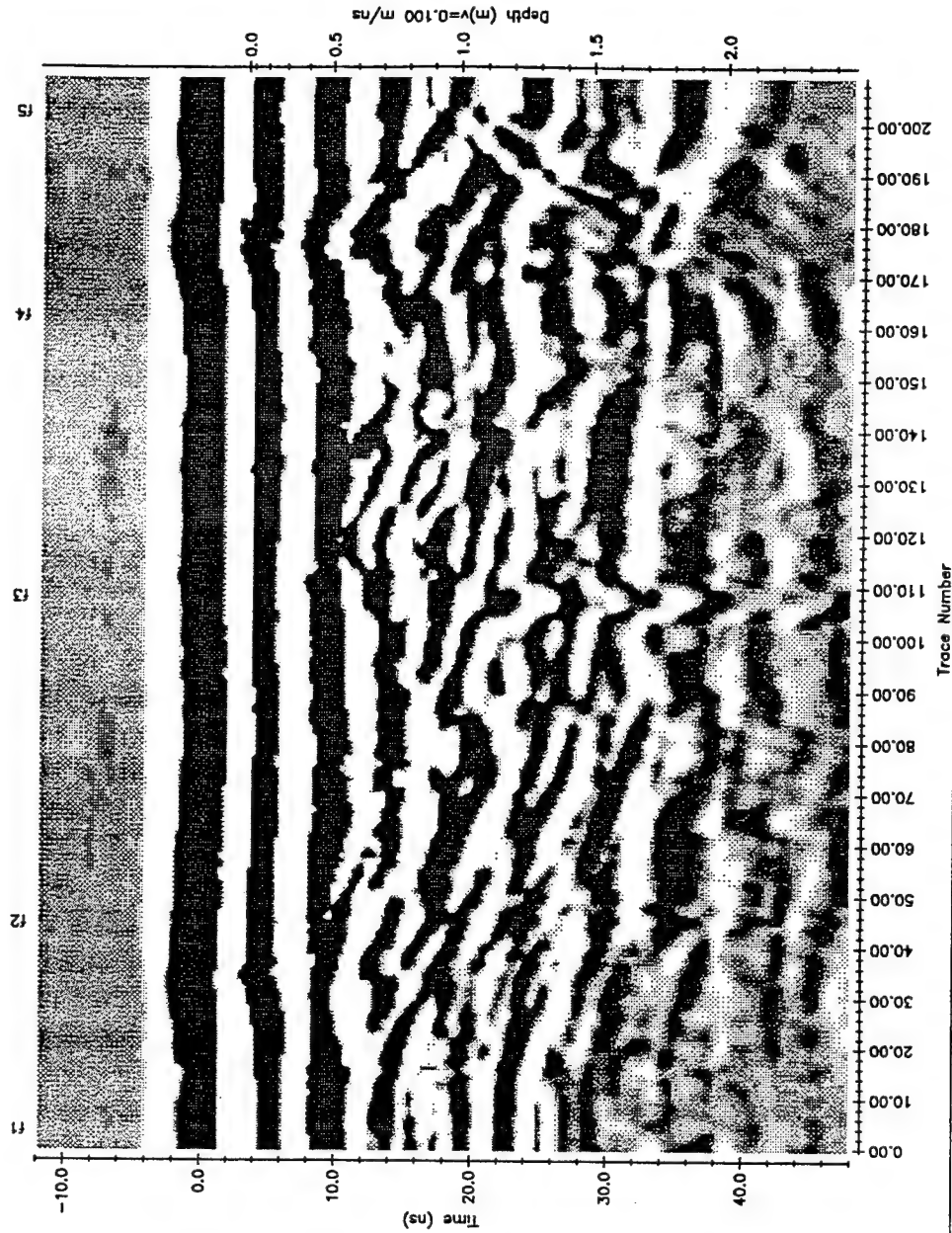
**Appendix A**  
**Crystal Gypsum**  
**GPR Records - Initial Investigation**

---

pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\20SEP0~1\CG225CP1  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Crystal Gypsum Pile, 225 MHz, Pipe - North Edge of Pile  
 DATE = 20/09/10  
 NUMBER OF TRACES = 210  
 NUMBER OF PTS/TRC = 200  
 TIMEZERO AT POINT = 40  
 TOTAL TIME WINDOW = 60  
 STARTING POSITION = 0.000  
 FINAL POSITION = 209.000  
 STEP SIZE USED = 1.000 metres  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 225.00  
 ANTENNA SEPARATION = 0.500  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971195/96

PROCESSING SELECTED:  
 FILTERS: TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 SELECTION TIME 12 to 48  
 POSITIONS: 0.000 to 209.000  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

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 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.0000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



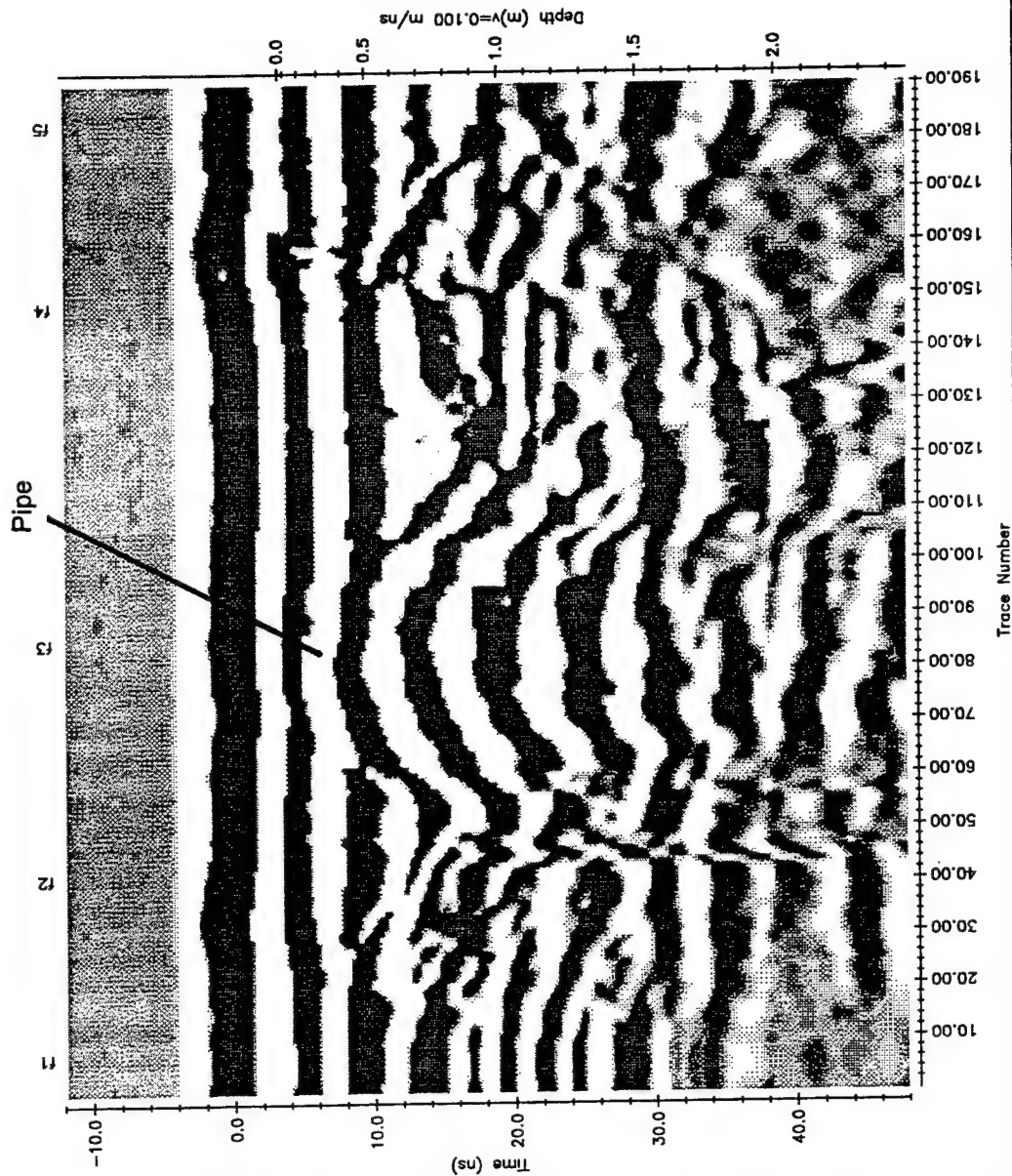
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 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Crystal Gypsum File, 225 MHz, Pipe - Profile Over Pipe  
 DATE = 20/09/10  
 NUMBER OF TRACES = 191  
 NUMBER OF PTS/TRC = 200  
 TIMEZERO AT POINT = 40  
 TOTAL TIME WINDOW = 60  
 STARTING POSITION = 0.000  
 FINAL POSITION = 190.000  
 STEP SIZE USED = 1.000 metres  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 225.00  
 ANTENNA SEPARATION = 0.500  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 COLLECTED BY PET000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971195/96

#### PROCESSING SELECTED

FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -12 to 48  
 POSITIONS: 0.000 to 190.000  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

#### PLOT LAYOUT PARAMETERS

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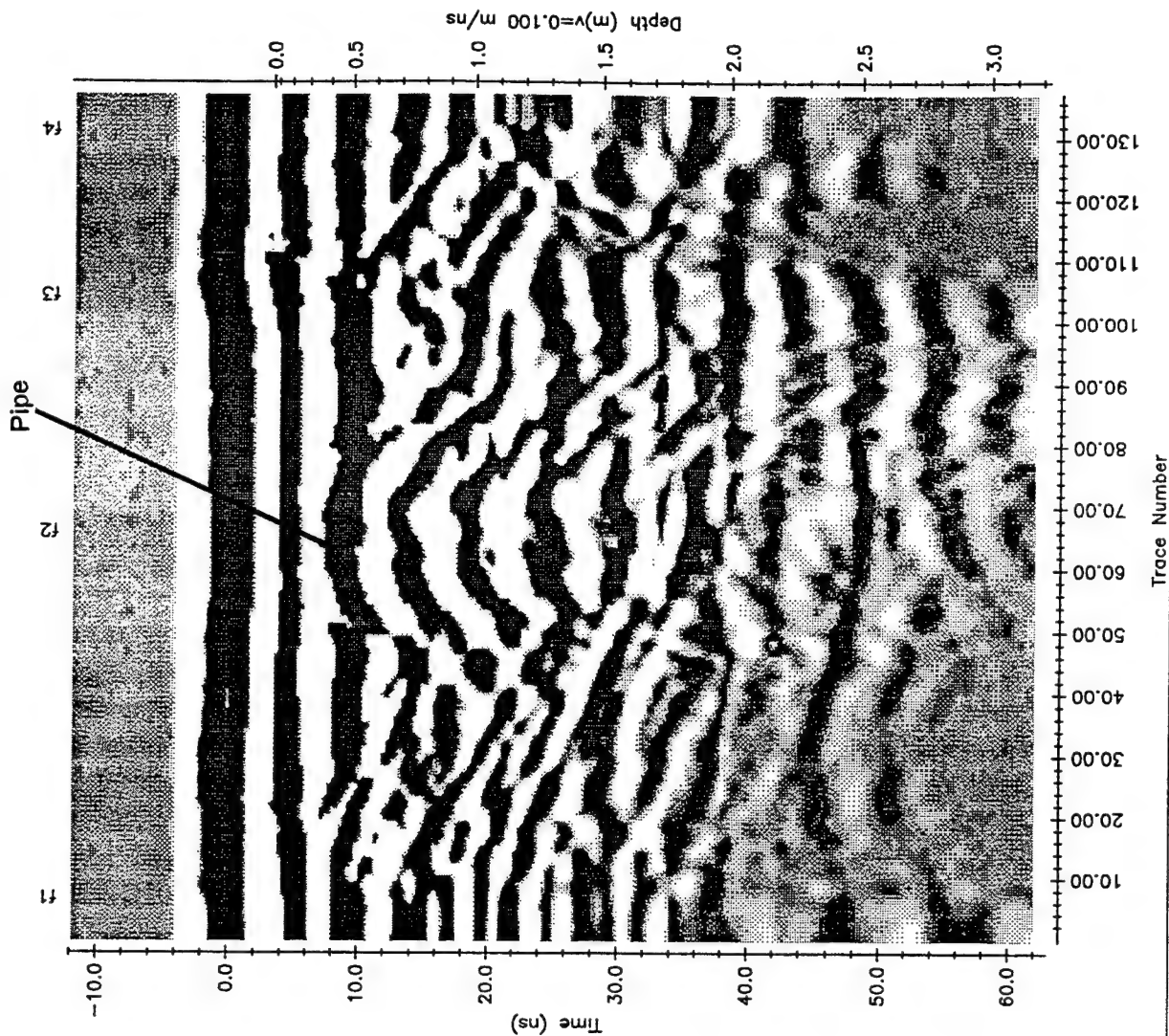
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 JOB# =  
 TITLE = Alabama Shipyard, Bulk Handling Area  
 TITLE = Crystal Gypsum Pile, 225 MHz, Pipe - South Edge of Pipe  
 DATE = 20/09/10  
 NUMBER OF TRACES = 138  
 NUMBER OF PTS/TRC = 250  
 TIMEZERO AT POINT = 43  
 TOTAL TIME WINDOW = 75  
 STARTING POSITION = 0.000  
 FINAL POSITION = 137.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 225.00  
 ANTENNA SEPARATION = 0.500  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971195/96

#### PROCESSING SELECTED

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 SELECTION  
 POSITIONS: 0.000 to 137.000  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

#### PLOT LAYOUT PARAMETERS

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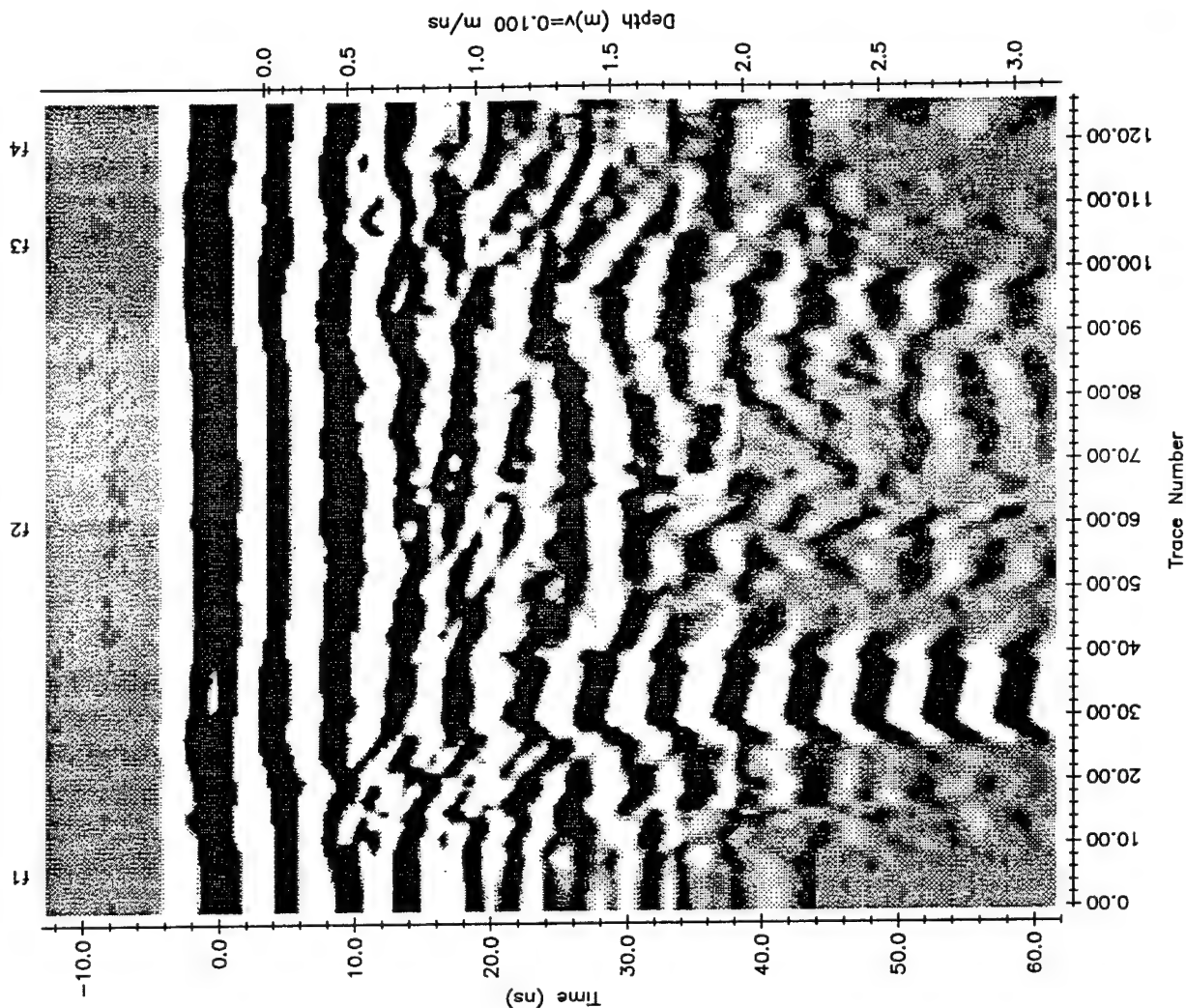




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 DATE = 20/09/10  
 NUMBER OF TRACES = 127  
 NUMBER OF PTS/TRC = 250  
 TIMEZERO AT POINT = 44  
 TOTAL TIME WINDOW = 75  
 STARTING POSITION = 0.000  
 FINAL POSITION = 126.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 225.00  
 ANTENNA SEPARATION = 0.500  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971195/96

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 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -13 to 62  
 POSITIONS: 0.000 to 126.000  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

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DATE = 20/09/10
NUMBER OF TRACES = 91
NUMBER OF PTS/TRC = 500
TIMEZERO AT POINT = 90
TOTAL TIME WINDOW = 50
STARTING POSITION = 0.000
FINAL POSITION = 90.000
STEP SIZE USED = 1.000
POSITION UNITS = metres
NOMINAL FREQUENCY = 450.00
ANTENNA SEPARATION = 0.250
PULSER VOLTAGE = 200
NUMBER OF STACKS = 16
SURVEY MODE = Reflection
COLLECTED BY PE1000 - CON: 981119 RX: 981120
TX: 981121 ANT: 971181/82

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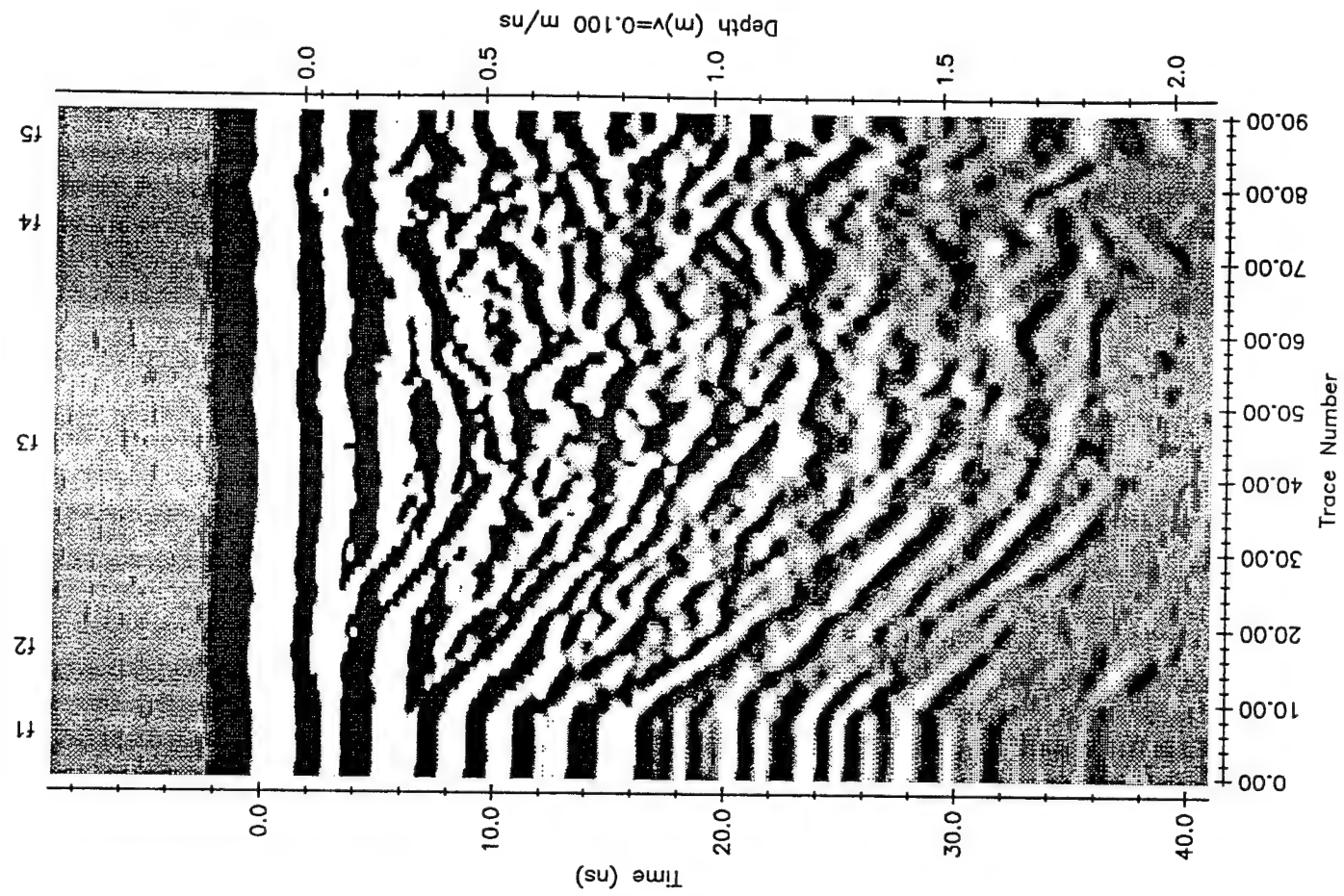
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TRACE DIFFERENCING: N
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SELECTION
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POSITIONS: 0.000 to 90.000
GAINS:
GAIN TYPE: CONSTANT
MULTIPLIER: 100.000

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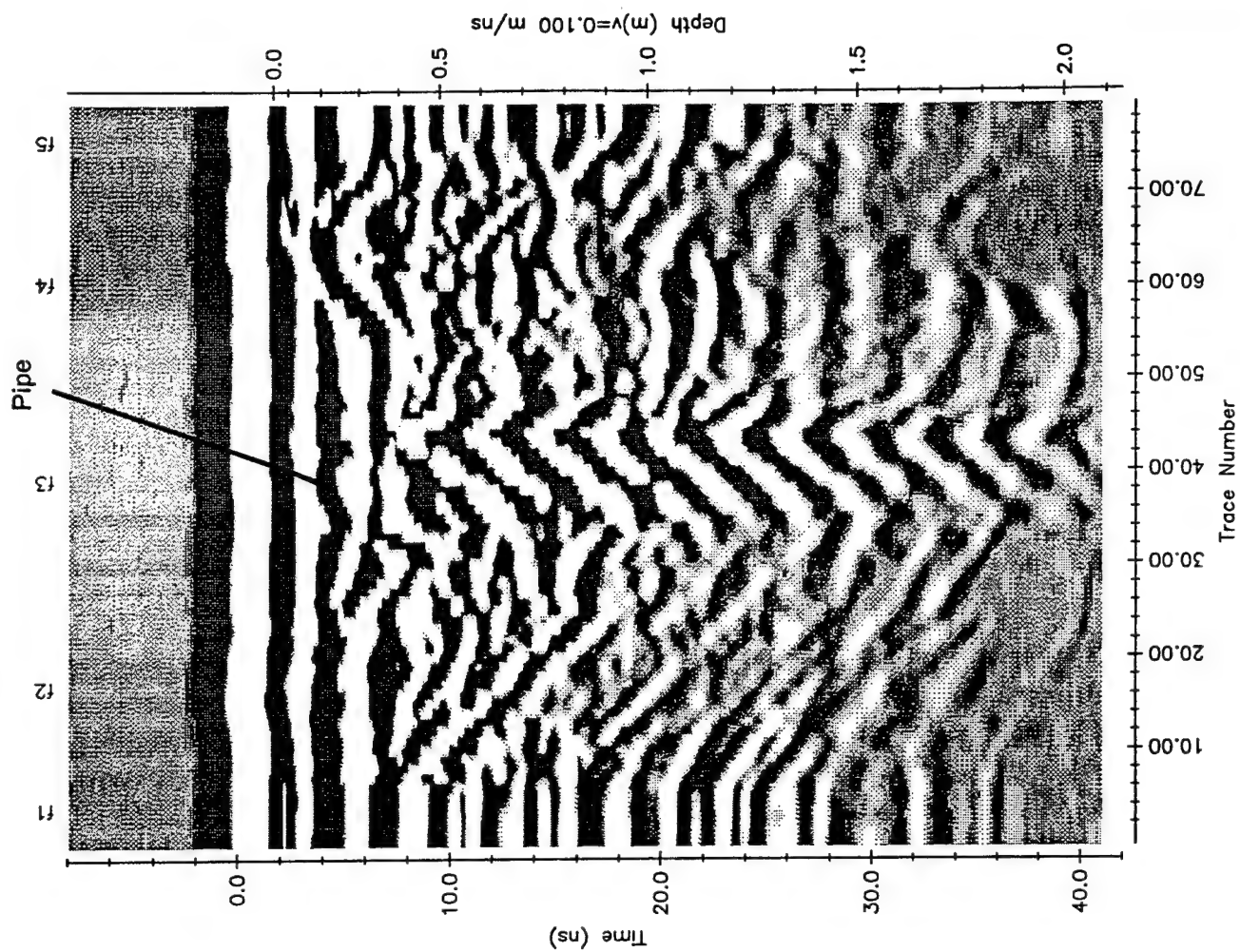
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 TITLE = Crystal Gypsum Pile, 450 MHz, Pipe - Profile Over Pipe  
 DATE = 20/09/10  
 NUMBER OF TRACES = 80  
 NUMBER OF PTS/TRC = 500  
 TIMEZERO AT POINT = 89  
 TOTAL TIME WINDOW = 50  
 STARTING POSITION = 0.000  
 FINAL POSITION = 79.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 450.00  
 ANTENNA SEPARATION = 0.250  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971181/82

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 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -8 to 42  
 SELECTION POSITIONS: 0.000 to 79.000  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS  
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 PAGE WIDTH: 10.0000  
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JOB# = Alabama Shipyard, Bulk Handling Area
TITLE = Crystal Gypsum Pile, 450 MHz, Pipe -- Over South Edge of Pipe
DATE = 20/09/10
NUMBER OF TRACES = 81
NUMBER OF PTS/TRC = 500
TIMEZERO AT POINT = 89
TOTAL TIME WINDOW = 50
STARTING POSITION = 0.000
FINAL POSITION = 80.000
STEP SIZE USED = 1.000
POSITION UNITS = metres
NOMINAL FREQUENCY = 450.00
ANTENNA SEPARATION = 0.250
PULSER VOLTAGE = 200
NUMBER OF STACKS = 16
SURVEY MODE = Reflection
COLLECTED BY PE1000 -- CON: 981119 RX: 981120
TX: 981121 ANT: 971181/82

```

```

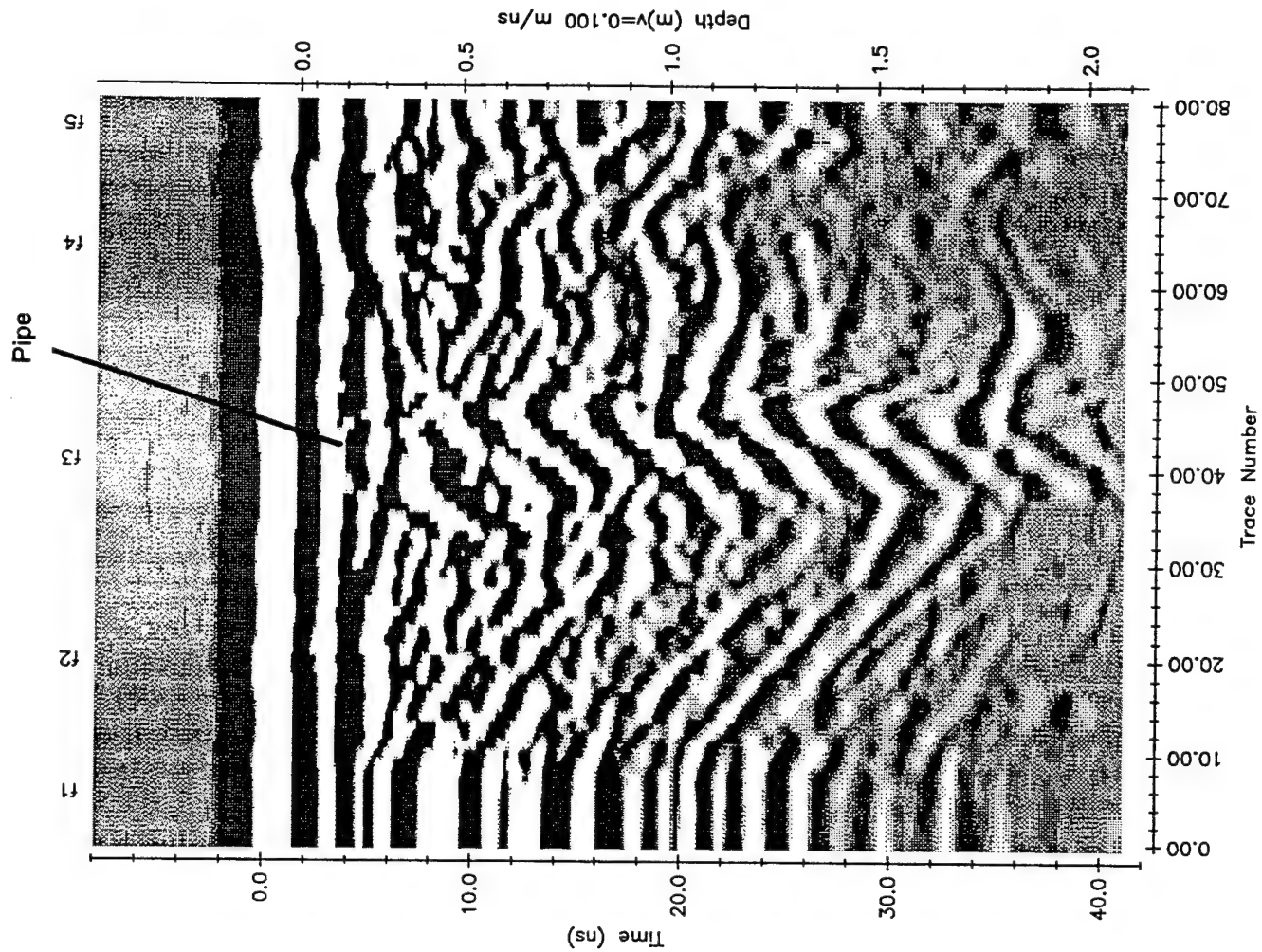
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FILTERS:
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POINT STACKING: 2
TRACE DIFFERENCING: N
CORRECTION: DEWOW
TIME: -8 to 42
SELECTION POSITIONS: 0.000 to 80.000
GAINS: GAIN TYPE: CONSTANT
MULTIPLIER: 100.000

```

```

PLOT LAYOUT PARAMETERS
TRACE SPACING AND WIDTH: 0.0700 and 0.2500
TRACE BOTTOM AND TOP: 1.0000 and 9.0000
MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
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BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0

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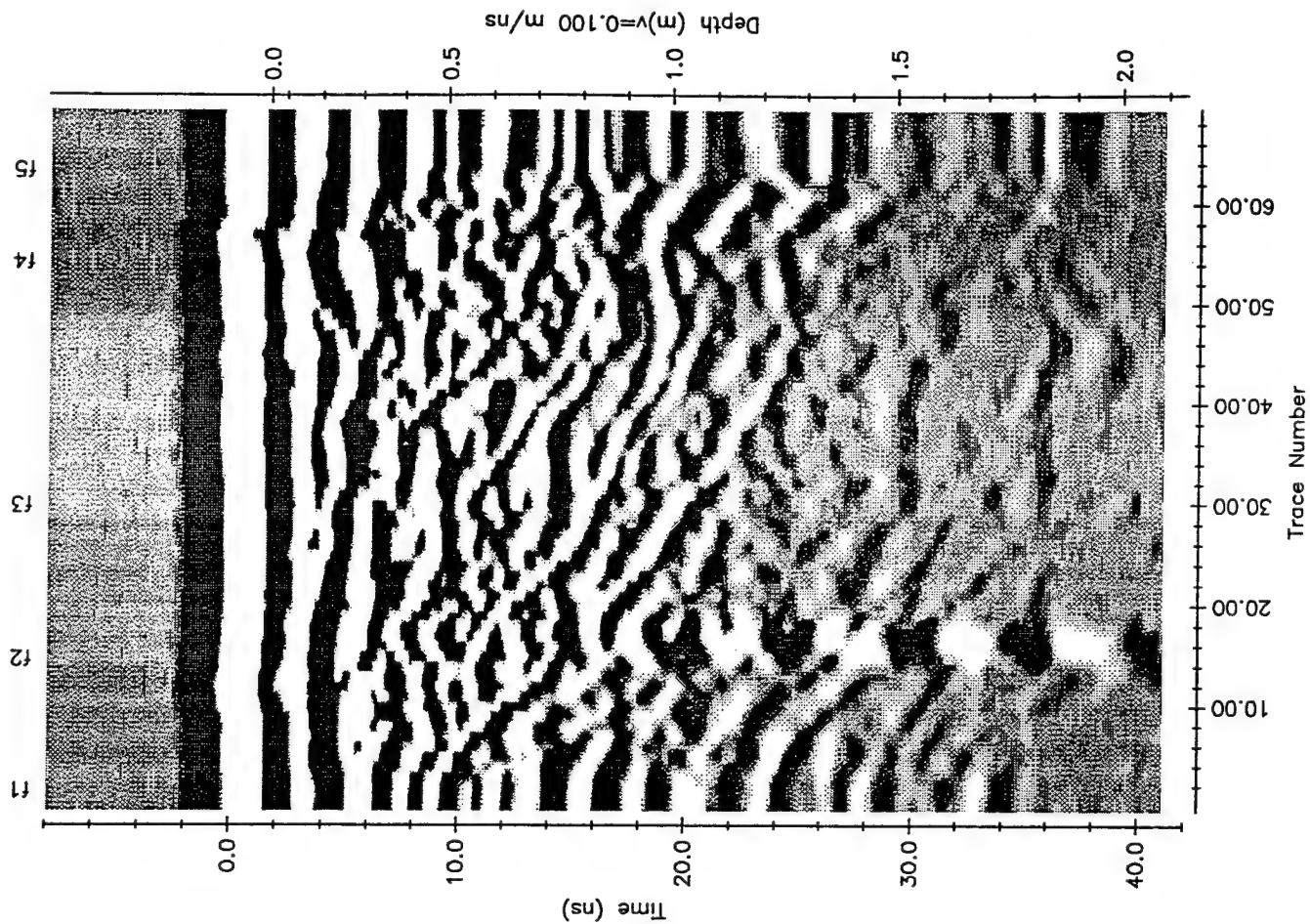




pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\20SEP0~1\CG450GP8  
 JOB# =  
 TITLE = Alabama Shipyard, Bulk Handling Area  
 TITLE = Crystal Gypsum Pile, 450 MHz, Pipe - South Edge of Pile  
 DATE = 20/09/10  
 NUMBER OF TRACES = 70  
 NUMBER OF PTS/TRC = 500  
 TIMEZERO AT POINT = 89  
 TOTAL TIME WINDOW = 50  
 STARTING POSITION = 0.000  
 FINAL POSITION = 69.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 450.00  
 ANTENNA SEPARATION = 0.250  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971181/82

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 SELECTION  
 TIME: -8 to 42  
 POSITIONS: 0.000 to 69.000  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

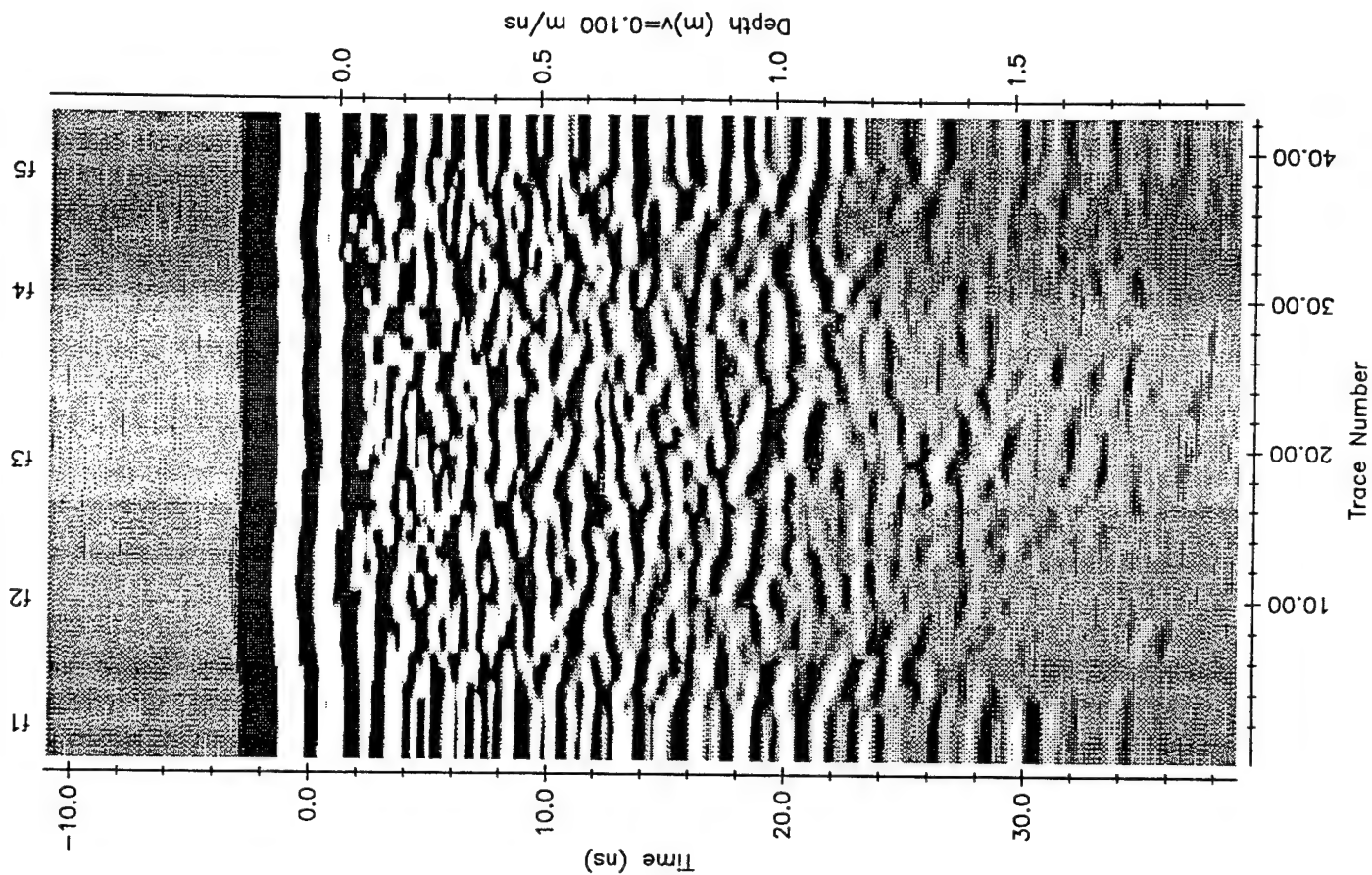
PLOT LAYOUT PARAMETERS  
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 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\20SEP0~1\CG900GP1  
 JOB# =  
 TITLE = Alabama Shipyard, Bulk Handling, Area  
 DATE = 20/09/10  
 TIME = 09:10  
 NUMBER OF TRACES = 43  
 NUMBER OF PTS/TRC = 1000  
 TIMEZERO AT POINT = 220  
 TOTAL TIME WINDOW = 50  
 STARTING POSITION = 0.000  
 FINAL POSITION = 42.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 900.00  
 ANTENNA SEPARATION = 0.170  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971258/59

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -11 to 39  
 POSITIONS: 0.000 to 42.000  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

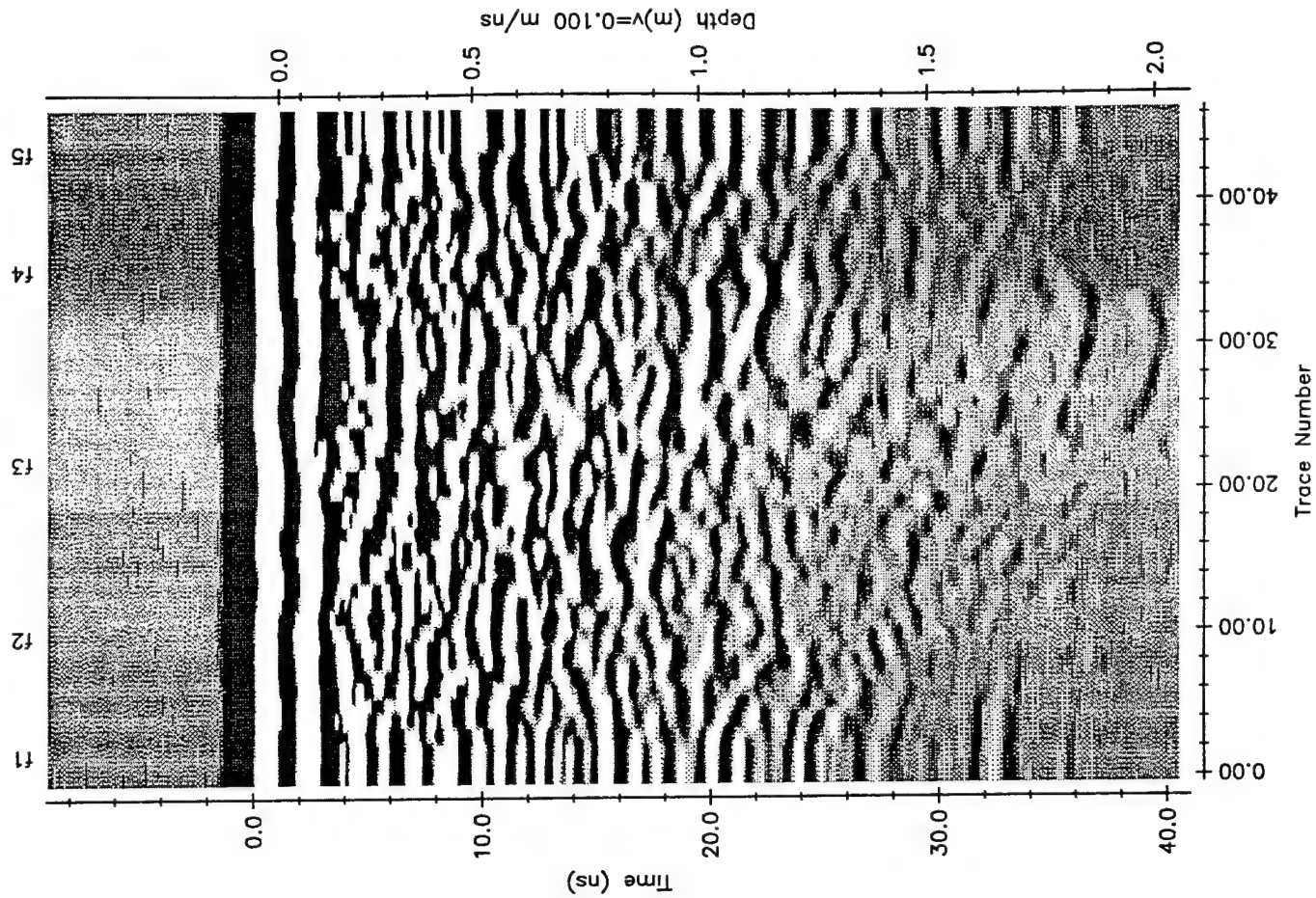
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 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\20SEP0~1\CG900GP2  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Crystal Gypsum Pile, 900 MHz, Pipe - Profile Over Pipe  
 DATE = 20/09/10  
 NUMBER OF TRACES = 47  
 NUMBER OF PTS/TRC = 1000  
 TIMEZERO AT POINT = 190  
 TOTAL TIME WINDOW = 50  
 STARTING POSITION = 0.000  
 FINAL POSITION = 46.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 900.00  
 ANTENNA SEPARATION = 0.170  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971258/59

PROCESSING SELECTED  
 FILTERS: TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -9 to 41  
 SELECTION POSITIONS: 0.000 to 46.000  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

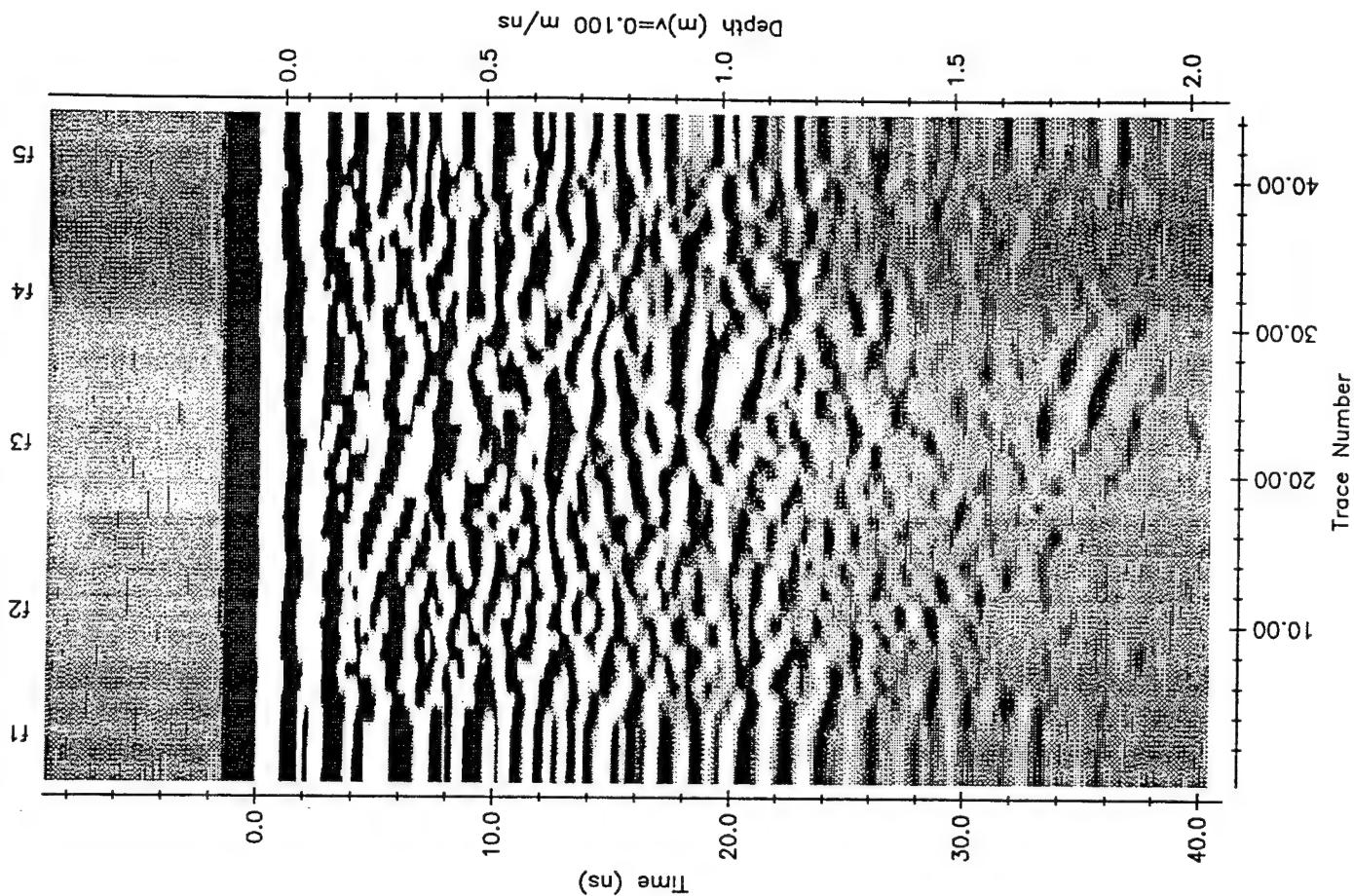
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 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\20SEP0~1\CG900GP3  
 JOB# =  
 TITLE = Alabama Shipyard, Bulk Handling Area  
 DATE = 20/09/10  
 NUMBER OF TRACES = 45  
 NUMBER OF PTS/TRC = 1000  
 TIMEZERO AT POINT = 192  
 TOTAL TIME WINDOW = 50  
 STARTING POSITION = 0.000  
 FINAL POSITION = 44.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 900.00  
 ANTENNA SEPARATION = 0.170  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971258/59

PROCESSING SELECTED  
 FILTERS: TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 SELECTION TIME: -9 to 41  
 POSITIONS: 0.000 to 44.000  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.1000 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0

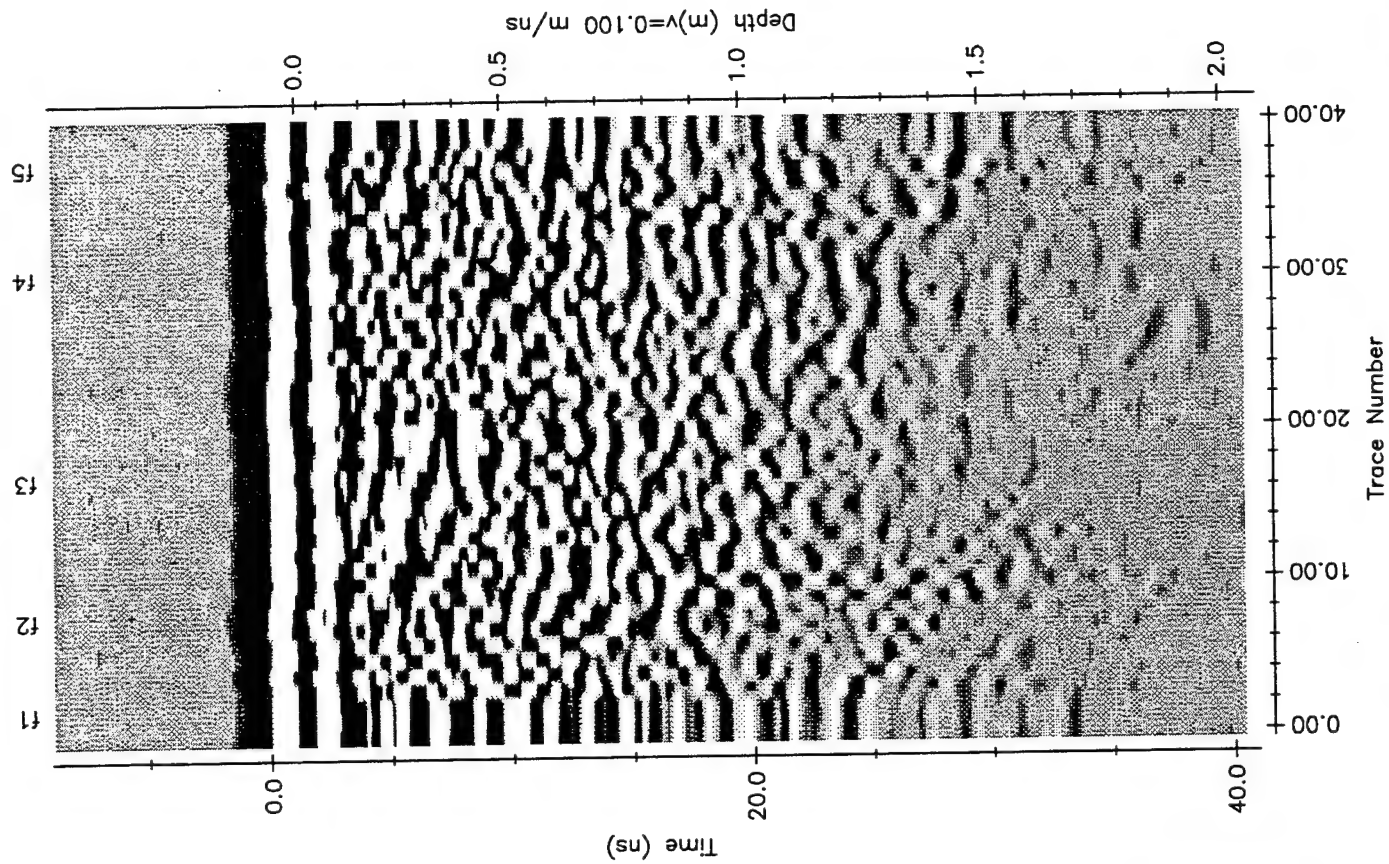




pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\20SEP0~1\CG900GP4  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Crystal Gypsum Pile, 900 MHz, Pipe - South Edge of Pile  
 DATE = 20/09/10  
 NUMBER OF TRACES = 41  
 NUMBER OF PTS/TRC = 1000  
 TIMEZERO AT POINT = 191  
 TOTAL TIME WINDOW = 50  
 STARTING POSITION = 0.000  
 FINAL POSITION = 40.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 900.00  
 ANTENNA SEPARATION = 0.170  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971258/59

PROCESSING SELECTED  
 FILTERS: TRACE STACKING: 1  
 POINT STACKING: 5  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 SELECTION TIME: -9 to 41  
 POSITIONS: 0.000 to 40.000  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

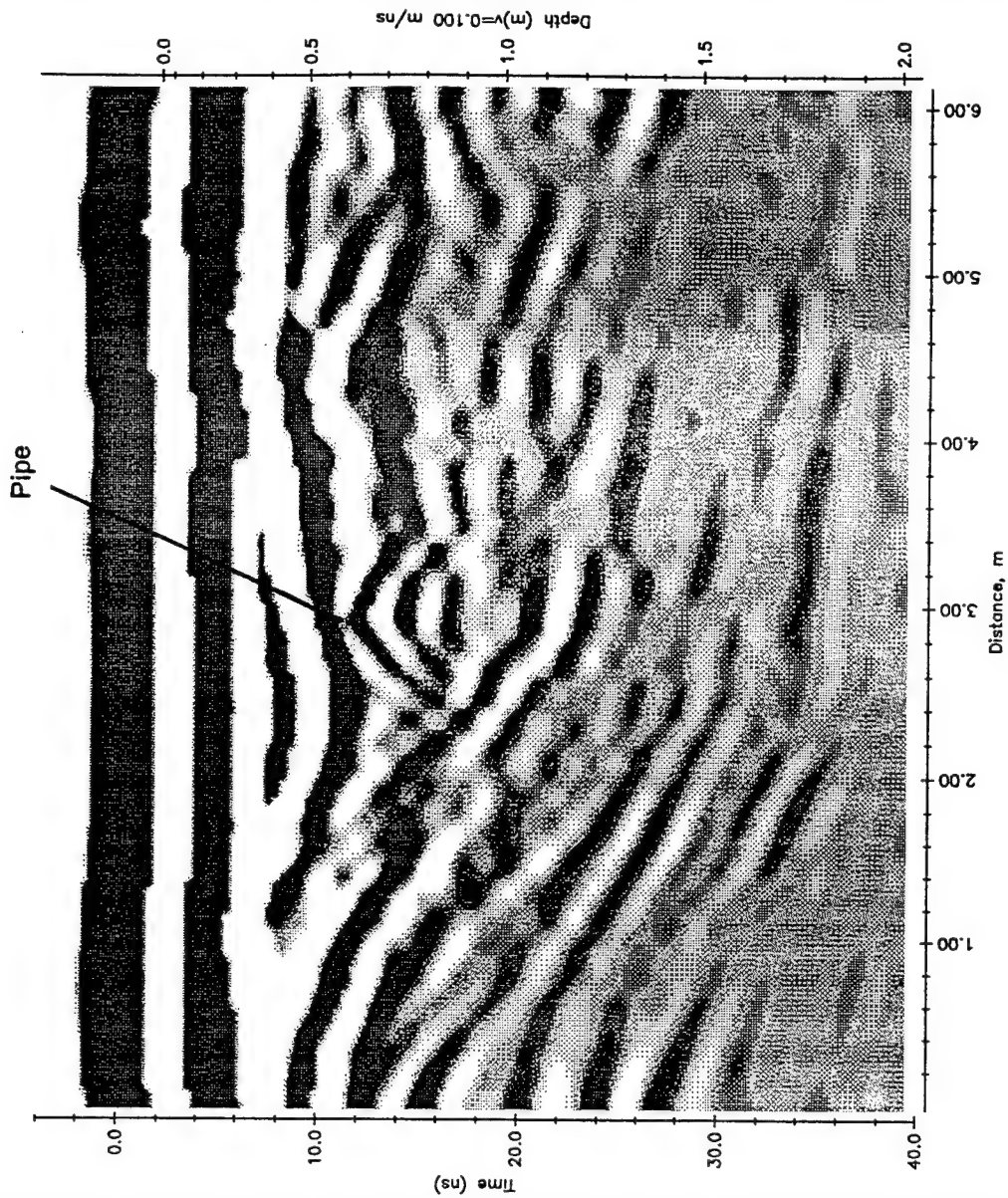
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 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG\1\20SEP0~1\CG250GFP0  
 JOB# =  
 TITLE = Alabama Shipyard, Bulk Handling Area  
 DATE = 09/20/2000  
 NUMBER OF TRACES = 123  
 NUMBER OF PTS/TRC = 111  
 TIMEZERO AT POINT = 11  
 TOTAL TIME WINDOW = 44  
 STARTING POSITION = 0.000  
 FINAL POSITION = 6.100  
 STEP SIZE USED = 0.050  
 POSITION UNITS = FT  
 NOMINAL FREQUENCY = 25.000  
 ANTENNA SEPARATION = 0.305  
 PULSER VOLTAGE = 100  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection

PROCESSING SELECTED  
 FILTERS: TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -4 to 40  
 POSITIONS: 0.000 to 6.100  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

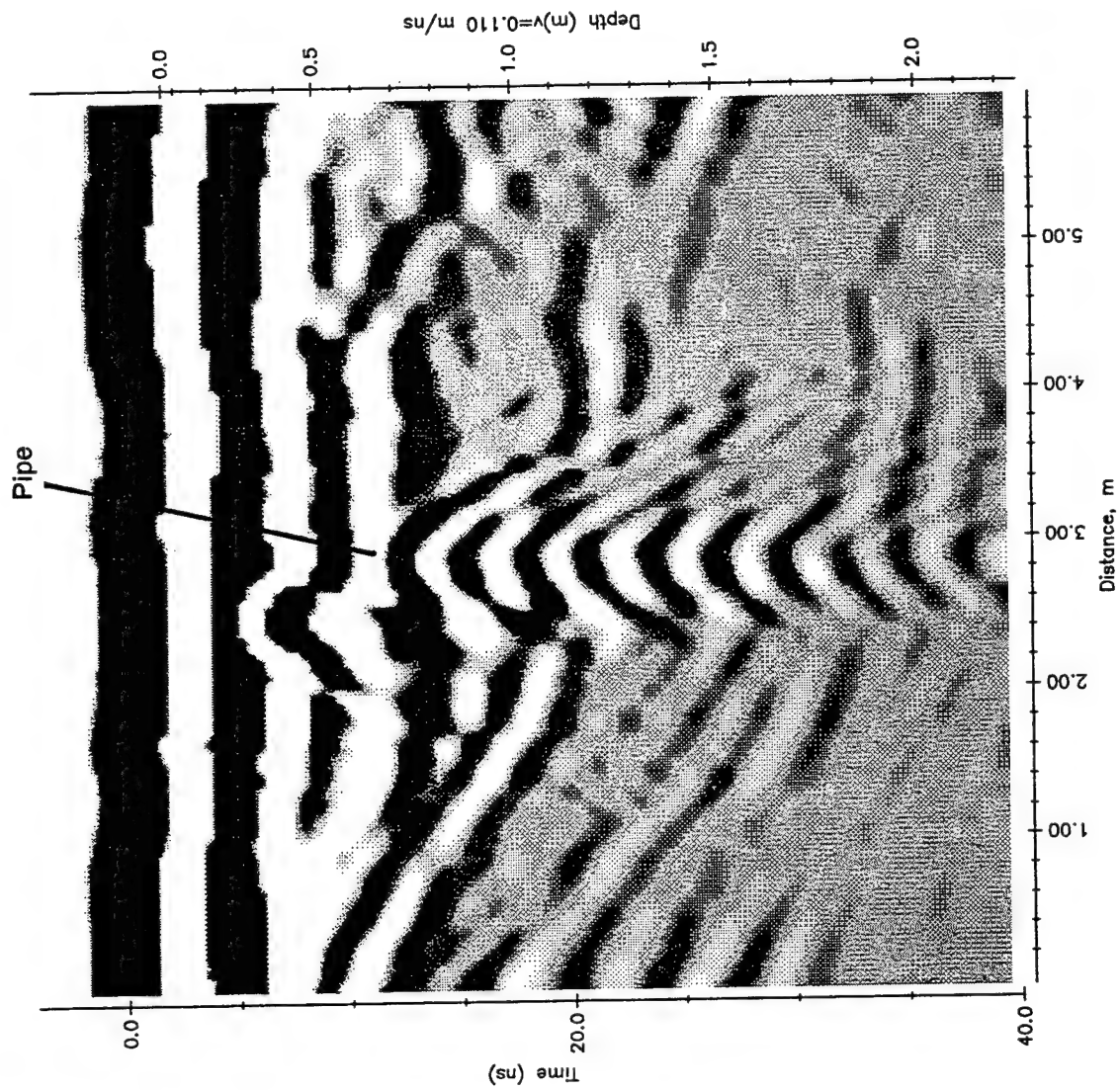
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 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\20SEP0~1\CG250CP1  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Crystal Gypsum Pile, 250 MHz, Pipe - Profile Over Pipe  
 DATE = 09/20/20  
 NUMBER OF TRACES = 120  
 NUMBER OF PTS/TRC = 111  
 TIMEZERO AT POINT = 11  
 TOTAL TIME WINDOW = 44  
 STARTING POSITION = 0.000  
 FINAL POSITION = 5.950  
 STEP SIZE USED = 0.050  
 POSITION UNITS = m  
 NOMINAL FREQUENCY = 250.00  
 ANTENNA SEPARATION = 0.305  
 PULSER VOLTAGE = 100  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection

PROCESSING SELECTED  
 FILTERS: TRACE STACKING: 1  
 POINT STACKING: 5  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 SELECTION TIME: -4 to 40  
 POSITIONS: 0.000 to 5.950  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

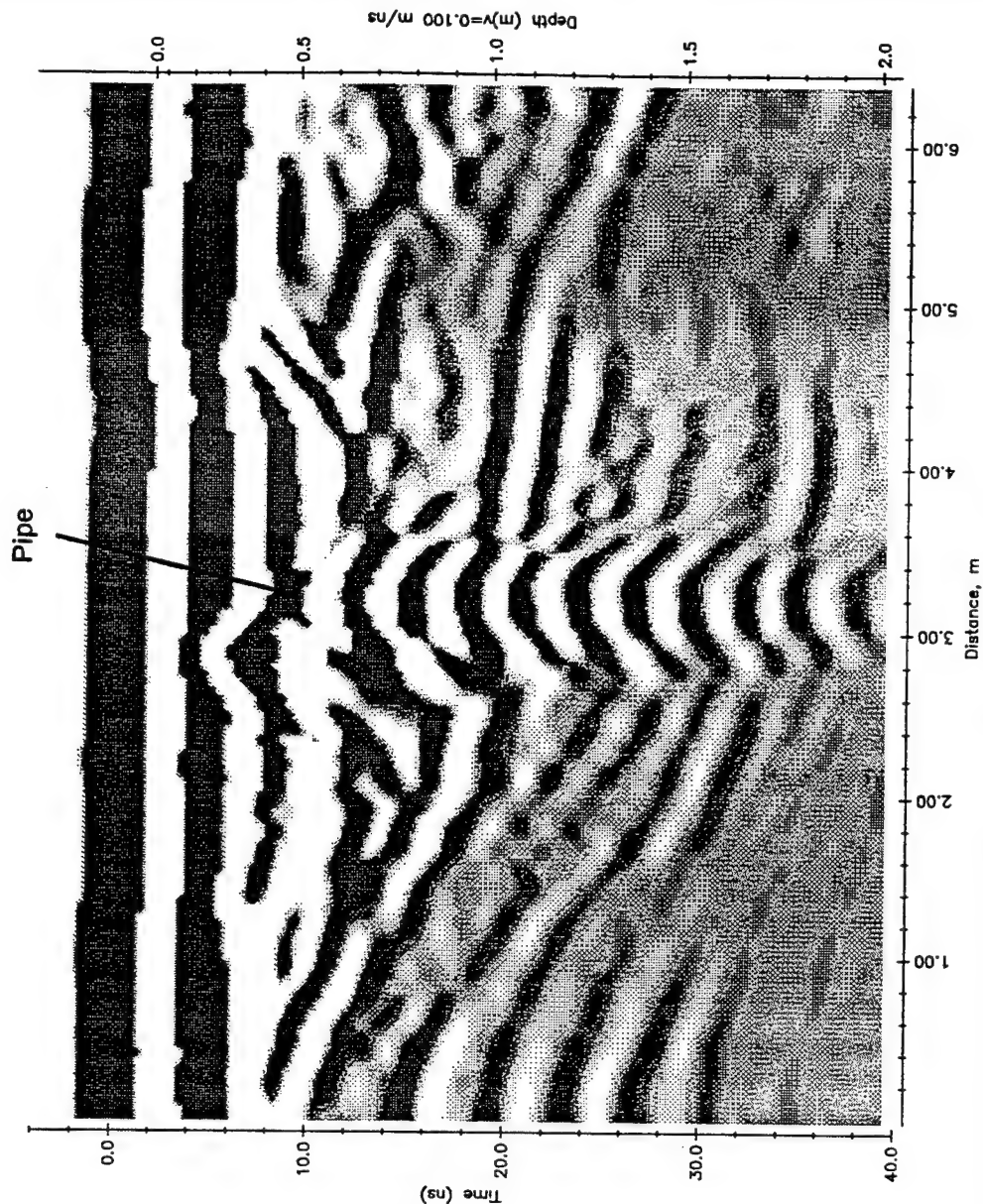
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 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\20SEP0~1\CG250GP3  
 JOB# =  
 TITLE = Alabama Shipyard, Bulk Handling Area  
 DATE = 09/20/20  
 NUMBER OF TRACES = 128  
 NUMBER OF PTS/TRC = 111  
 TIMEZERO AT POINT = 11  
 TOTAL TIME WINDOW = 44  
 STARTING POSITION = 0.000  
 FINAL POSITION = 6.350  
 STEP SIZE USED = 0.050  
 POSITION UNITS = m  
 NOMINAL FREQUENCY = 250.00  
 ANTENNA SEPARATION = 0.305  
 PULSER VOLTAGE = 100  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection

PROCESSING SELECTED  
 FILTERS: TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -4 to 40  
 SELECTION POSITIONS: 0.000 to 6.350  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

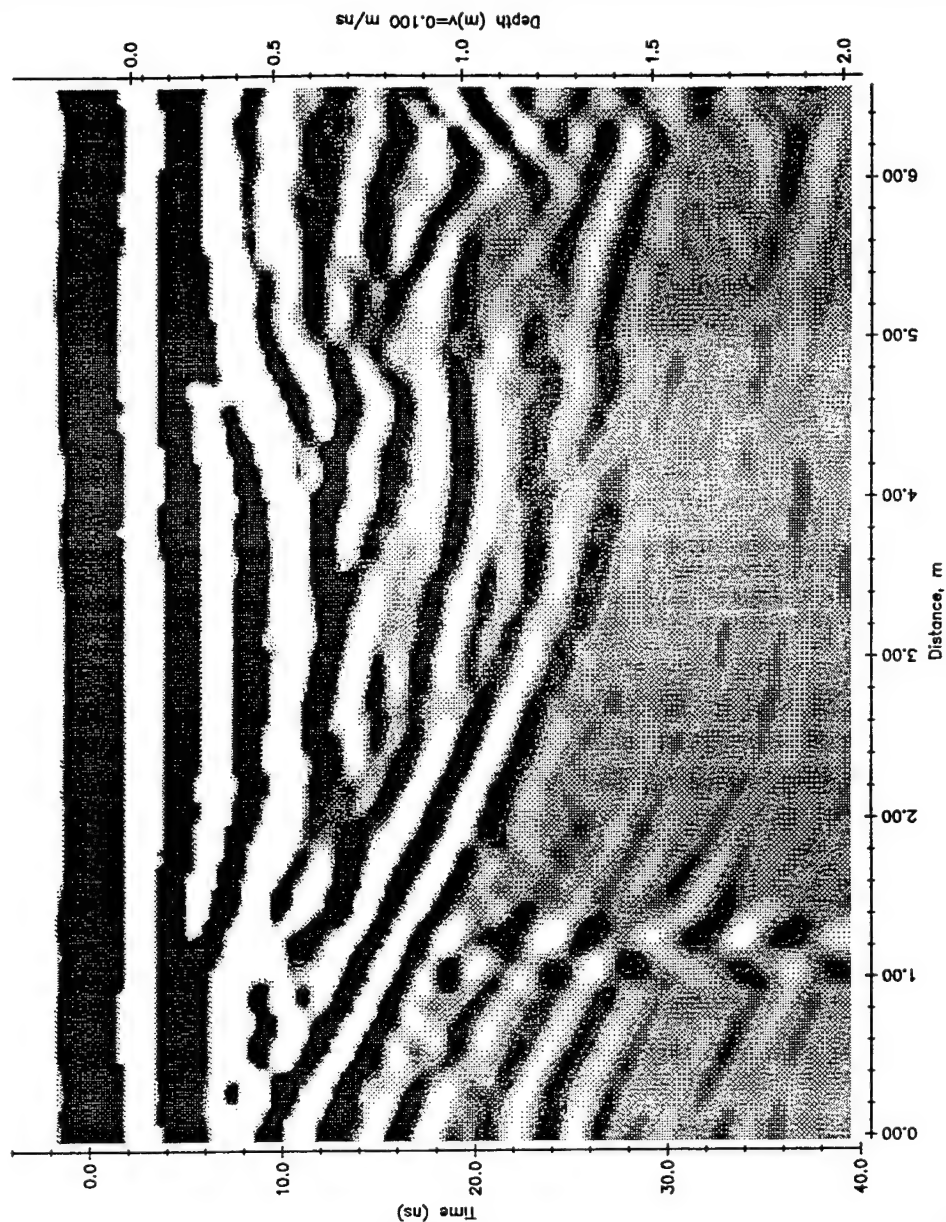
PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.0750 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\20SEPO~1\CG250GP5  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Crystal Gypsum Pile, 250 MHz, Pipe - South Edge of Pile  
 DATE = 09/20/20  
 NUMBER OF TRACES = 132  
 NUMBER OF PTS/TRC = 111  
 TIMEZERO AT POINT = 44  
 TOTAL TIME WINDOW = 0.000  
 STARTING POSITION = 6.550  
 FINAL POSITION = 0.050  
 STEP SIZE USED = m  
 POSITION UNITS = 250.00  
 NOMINAL FREQUENCY = 0.305  
 ANTENNA SEPARATION = 100  
 PULSER VOLTAGE = 16  
 NUMBER OF STACKS = Reflection  
 SURVEY MODE =

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -4 to 40  
 POSITIONS: 0.000 to 6.550  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.0750 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0





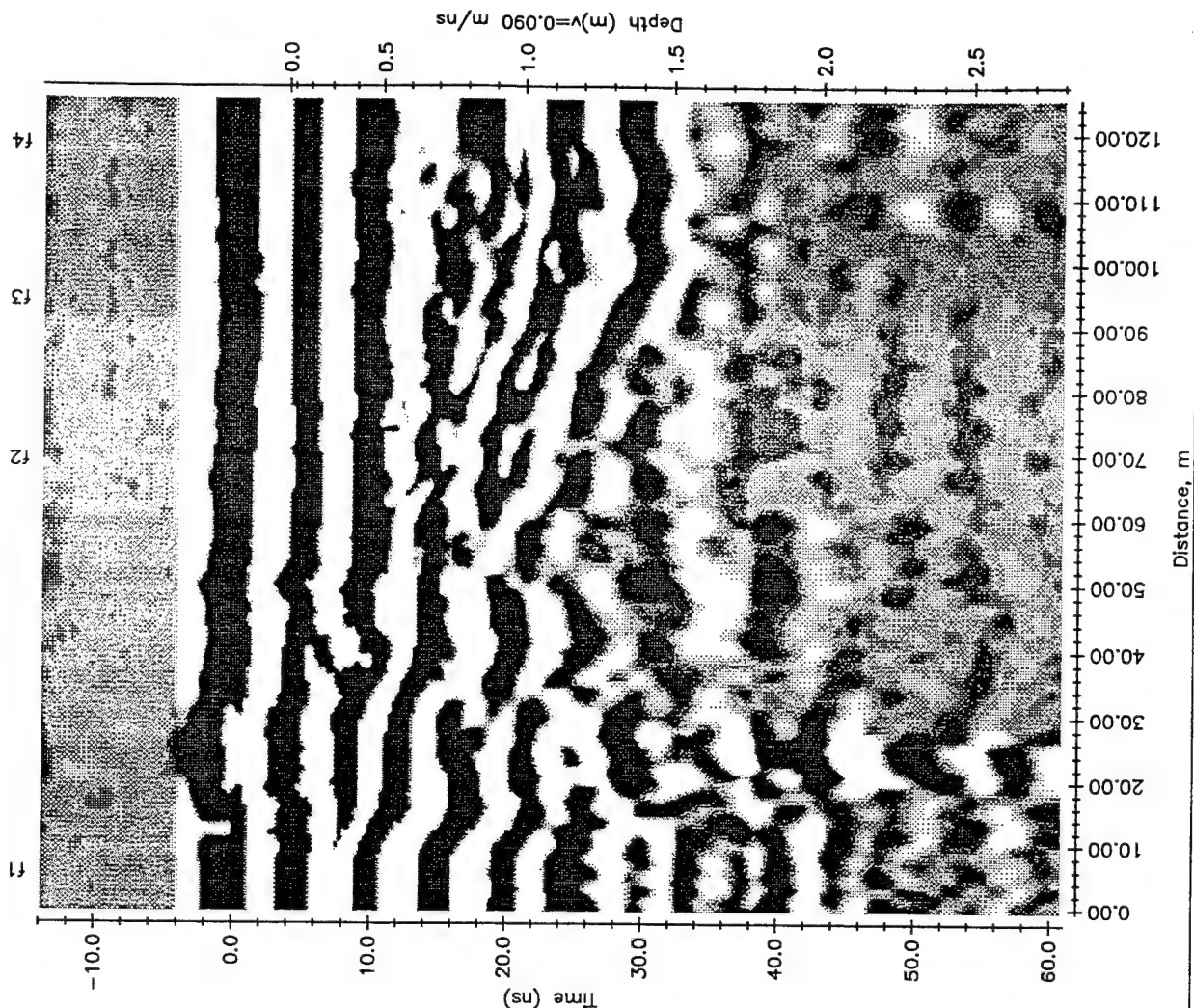
**Appendix B**  
**Powdered Gypsum**  
**GPR Records - Initial Investigation**

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pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\20SEP0~1\CG225PP1  
 JOB# =  
 TITLE = Alabama Shipyard, Bulk Handling Area  
 TITLE = Powdered Gypsum Pile, 225 MHz, Pipe - West Edge of Pile  
 DATE = 20/09/10  
 NUMBER OF TRACES = 126  
 NUMBER OF PTS/TRC = 250  
 TIMEZERO AT POINT = 47  
 TOTAL TIME WINDOW = 75  
 STARTING POSITION = 0.000  
 FINAL POSITION = 125.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 225.00  
 ANTENNA SEPARATION = 0.500  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971195/96

PROCESSING SELECTED  
 FILTERS: TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -14 to 61  
 SELECTION POSITIONS: 0.000 to 125.000  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

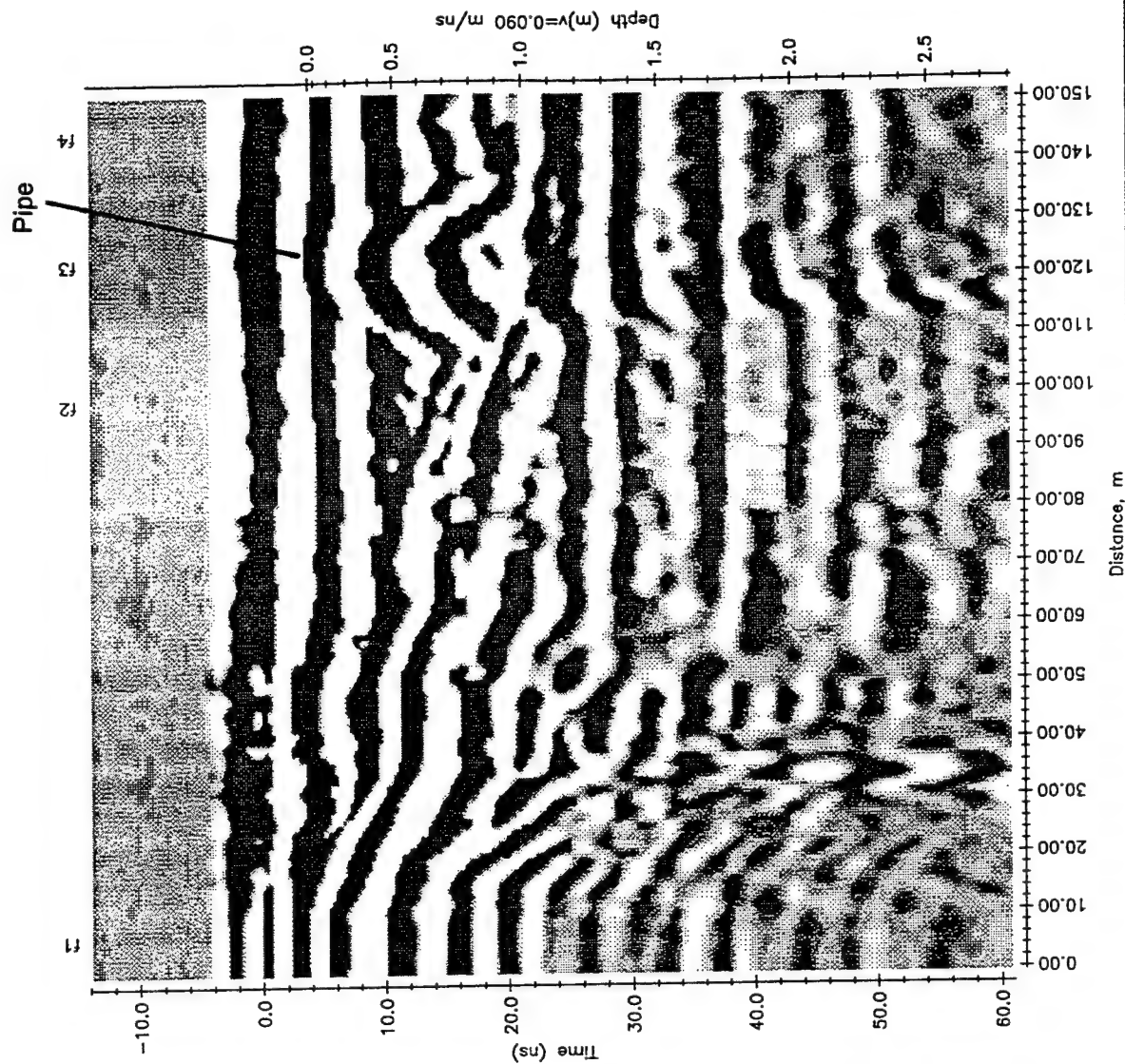
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 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\20SEP0~1\CG2225PP2  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Powdered Gypsum Pile, 225 MHz, Pipe - Profile Over Pipe  
 DATE = 20/09/10  
 NUMBER OF TRACES = 152  
 NUMBER OF PTS/TRC = 250  
 TIMEZERO AT POINT = 47  
 TOTAL TIME WINDOW = 75  
 STARTING POSITION = 0.000  
 FINAL POSITION = 151.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 225.00  
 ANTENNA SEPARATION = 0.500  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971195/96

PROCESSING SELECTED  
 FILTERS: TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -14 to 61  
 SELECTION POSITIONS: 0.000 to 151.000  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.0500 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0

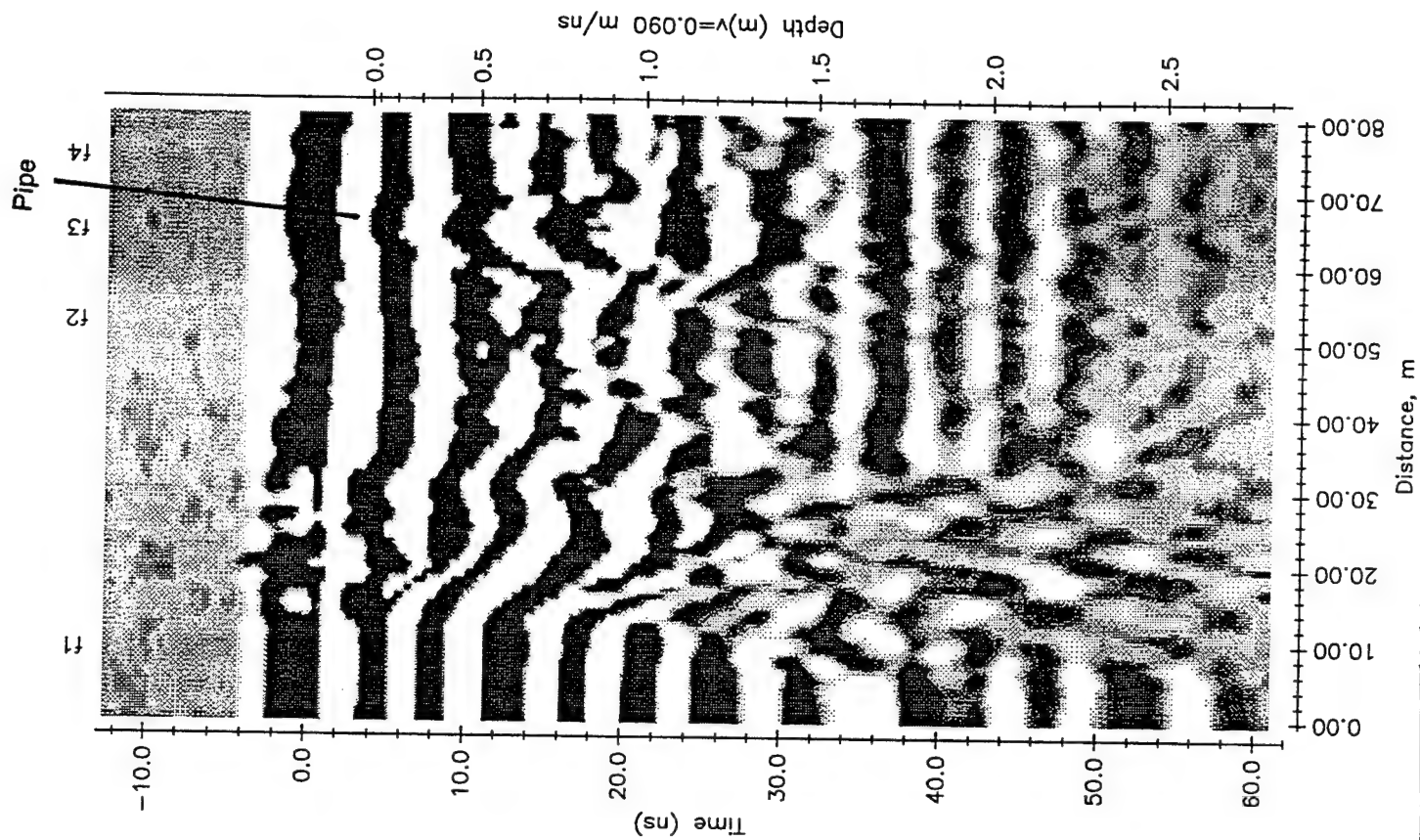




pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\20SEP0~1\CG225PP3  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Powdered Gypsum Pile, 225 MHz, Pipe -- Profile Over Pipe  
 DATE = 20/09/10  
 NUMBER OF TRACES = 81  
 NUMBER OF PTS/TRC = 250  
 TIMEZERO AT POINT = 46  
 TOTAL TIME WINDOW = 75  
 STARTING POSITION = 0.000  
 FINAL POSITION = 80.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 225.00  
 ANTENNA SEPARATION = 0.500  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971195/96

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -13 to 62  
 POSITIONS: 0.000 to 80.000  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

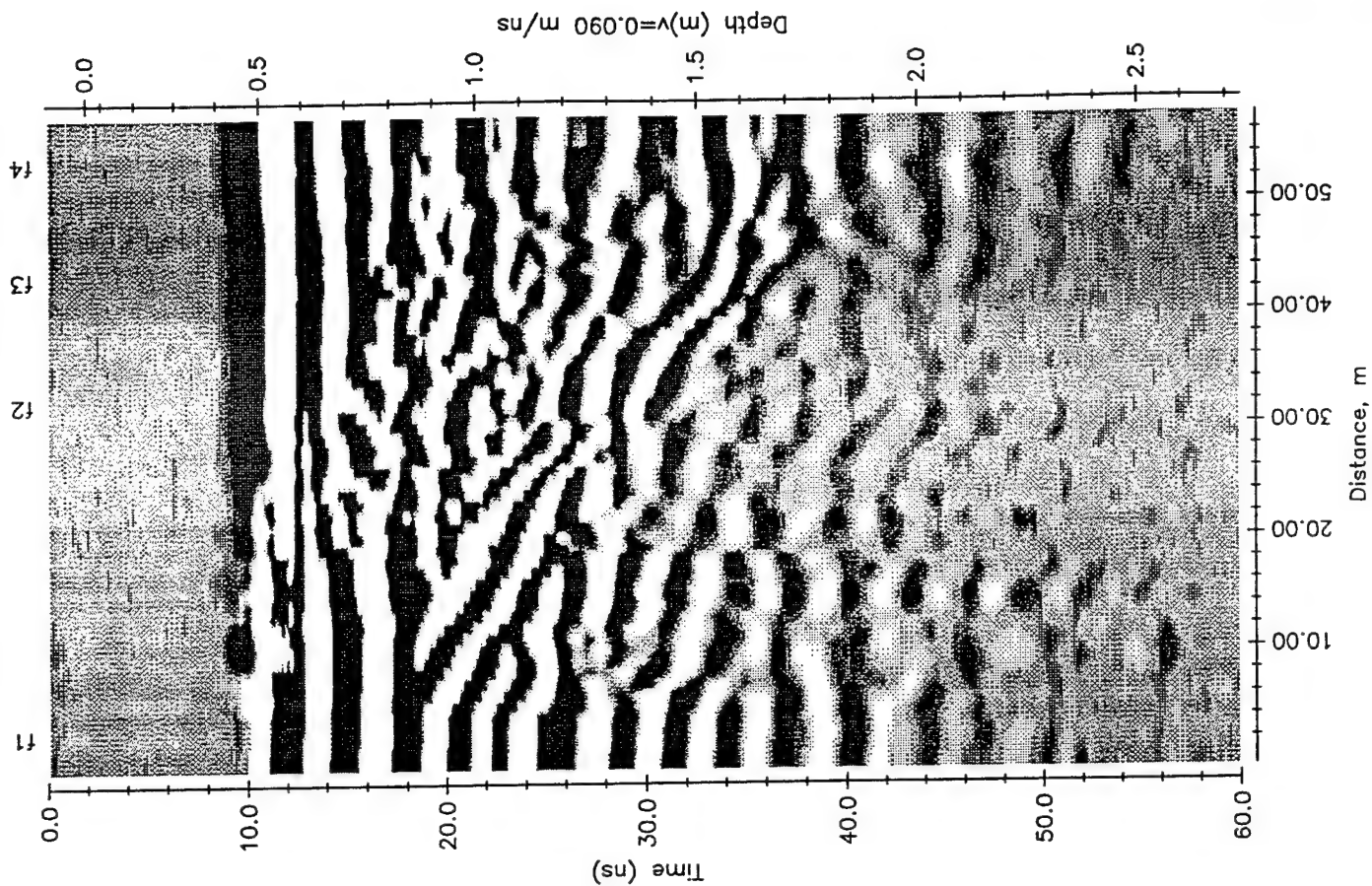
PLOT LAYOUT PARAMETERS  
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 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
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 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\20SEP0~1\CG450PP1  
 JOB# =  
 TITLE = Alabama Shipyard, Bulk Handling Area  
 TITLE = Powdered Gypsum Pile, 450 MHz, Pipe - West Edge of Pile  
 DATE = 20/09/10  
 NUMBER OF TRACES = 58  
 NUMBER OF PTS/TRC = 600  
 TIMEZERO AT POINT = 1  
 TOTAL TIME WINDOW = 60  
 STARTING POSITION = 0.000  
 FINAL POSITION = 57.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 450.00  
 ANTENNA SEPARATION = 0.250  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971181/82

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 SELECTION  
 TIME: 0 to 60  
 POSITIONS: 0.000 to 57.000  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.0750 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
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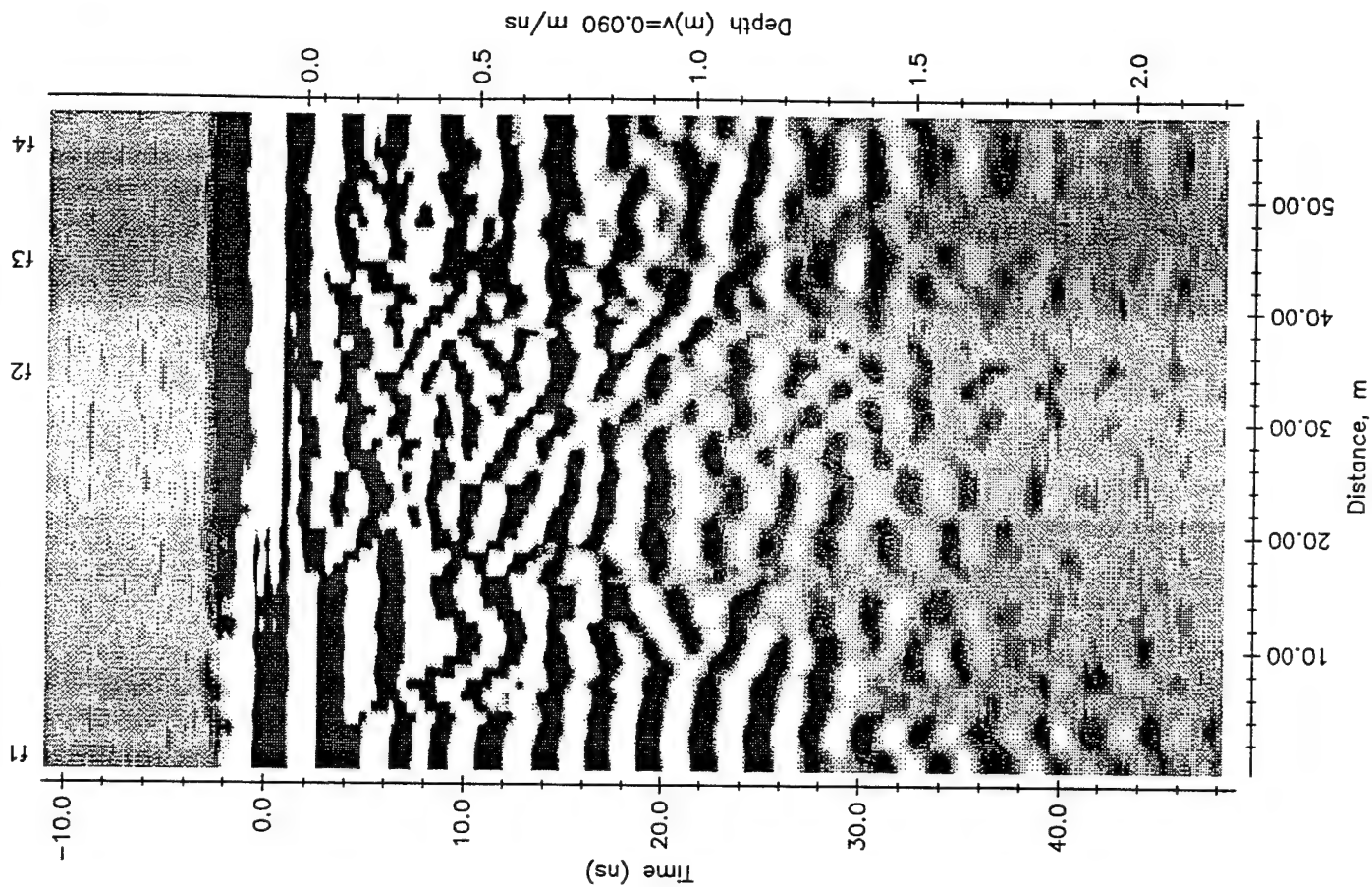
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 JOB# =  
 TITLE = Alabama Shipyard, Bulk Handling Area  
 DATE = 20/09/10  
 TIME = 09:10  
 NUMBER OF TRACES = 58  
 NUMBER OF PTS/TRC = 600  
 TIMEZERO AT POINT = 117  
 TOTAL TIME WINDOW = 60  
 STARTING POSITION = 0.000  
 FINAL POSITION = 57.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 450.00  
 ANTENNA SEPARATION = 0.250  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971181/82

# PROCESSING SELECTED

FILTERS: TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -11 to 49  
 POSITIONS: 0.000 to 57.000  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

# PLOT LAYOUT PARAMETERS

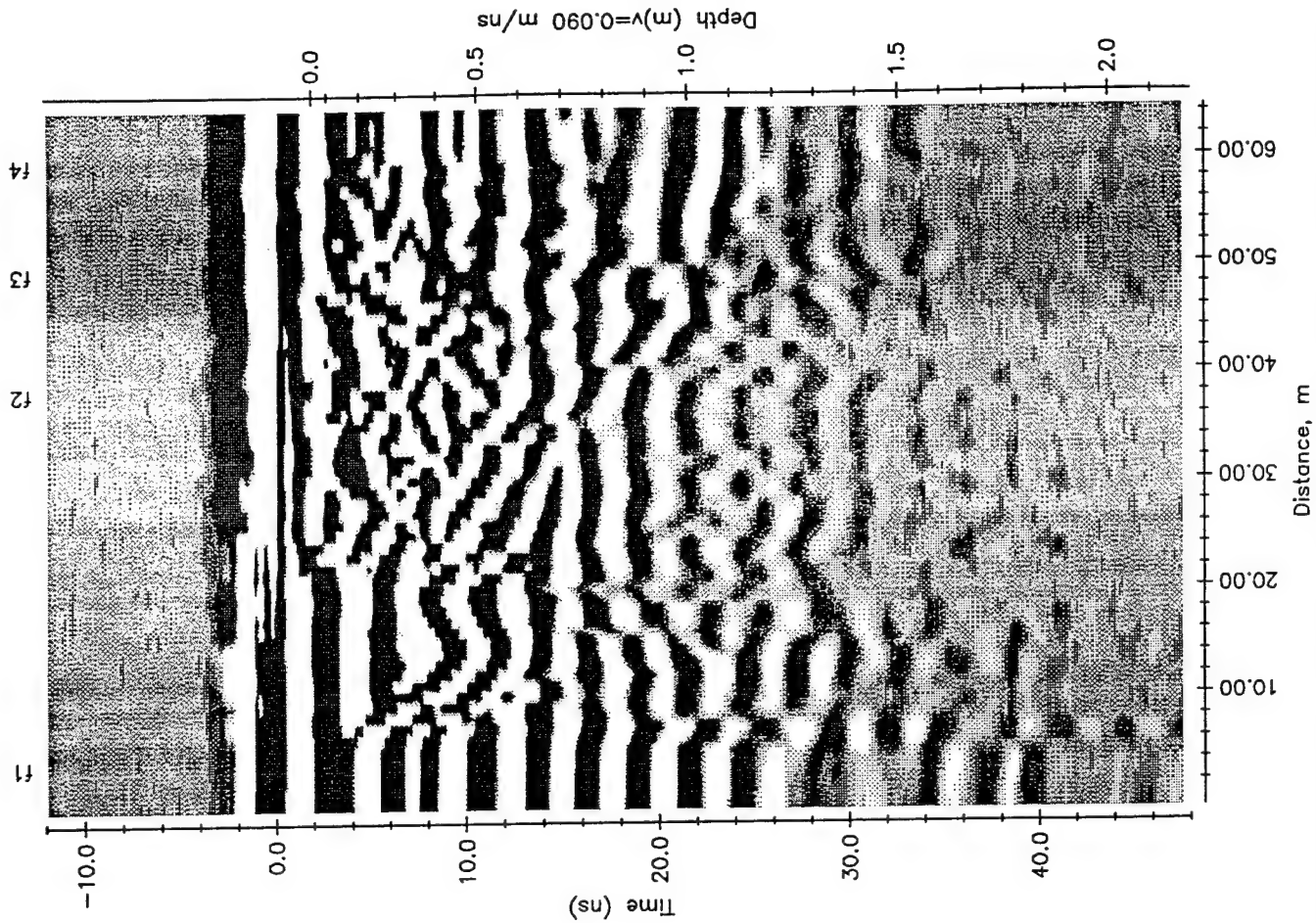
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 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\20SEP0~1\CG450PP3  
 JOB# =  
 TITLE = Alabama Shipyard, Bulk Handling Area  
 TITLE = Powdered Gypsum Pile, 450 MHz, Pipe -- Profile Over Pipe  
 DATE = 20/09/10  
 NUMBER OF TRACES = 65  
 NUMBER OF PTS/TRC = 600  
 TIMEZERO AT POINT = 124  
 TOTAL TIME WINDOW = 60  
 STARTING POSITION = 0.000  
 FINAL POSITION = 64.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 450.00  
 ANTENNA SEPARATION = 0.250  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971181/82

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -12 to 48  
 SELECTION  
 POSITIONS: 0.000 to 64.000  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS  
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 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
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 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0





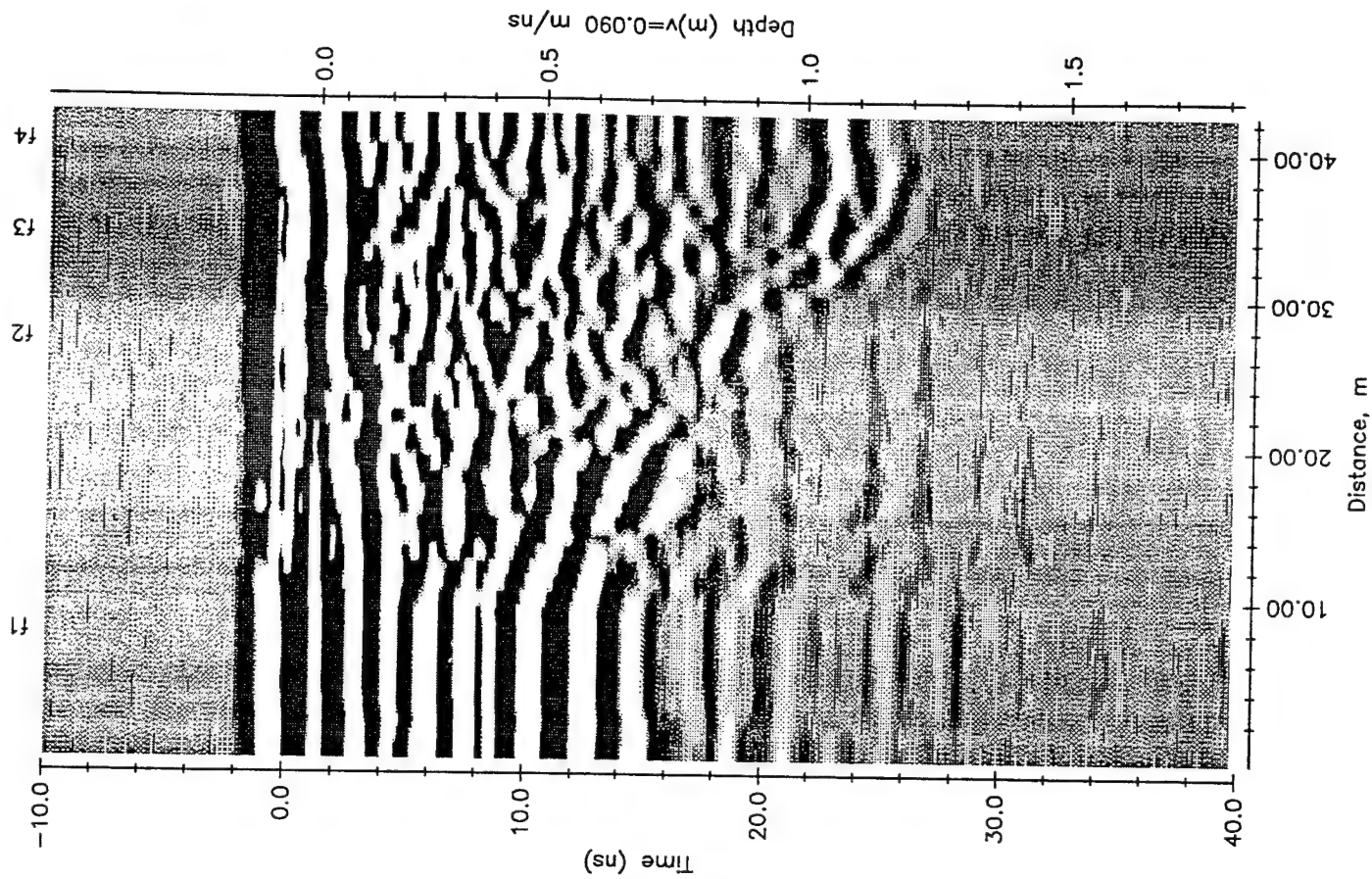
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 FILE = s:\COASTG~1\20SEP0~1\CG9000PP1  
 JOB# =  
 TITLE = Alabama Shipyard, Bulk Handling Area  
 DATE = 20/09/10  
 NUMBER OF TRACES = 43  
 NUMBER OF PTS/TRC = 1000  
 TIMEZERO AT POINT = 205  
 TOTAL TIME WINDOW = 50  
 STARTING POSITION = 0.000  
 FINAL POSITION = 42.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 900.00  
 ANTENNA SEPARATION = 0.170  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971258/59

#### PROCESSING SELECTED

FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -10 to 40  
 POSITIONS: 0.000 to 42.000  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

#### PLOT LAYOUT PARAMETERS

TRACE SPACING AND WIDTH: 0.1000 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
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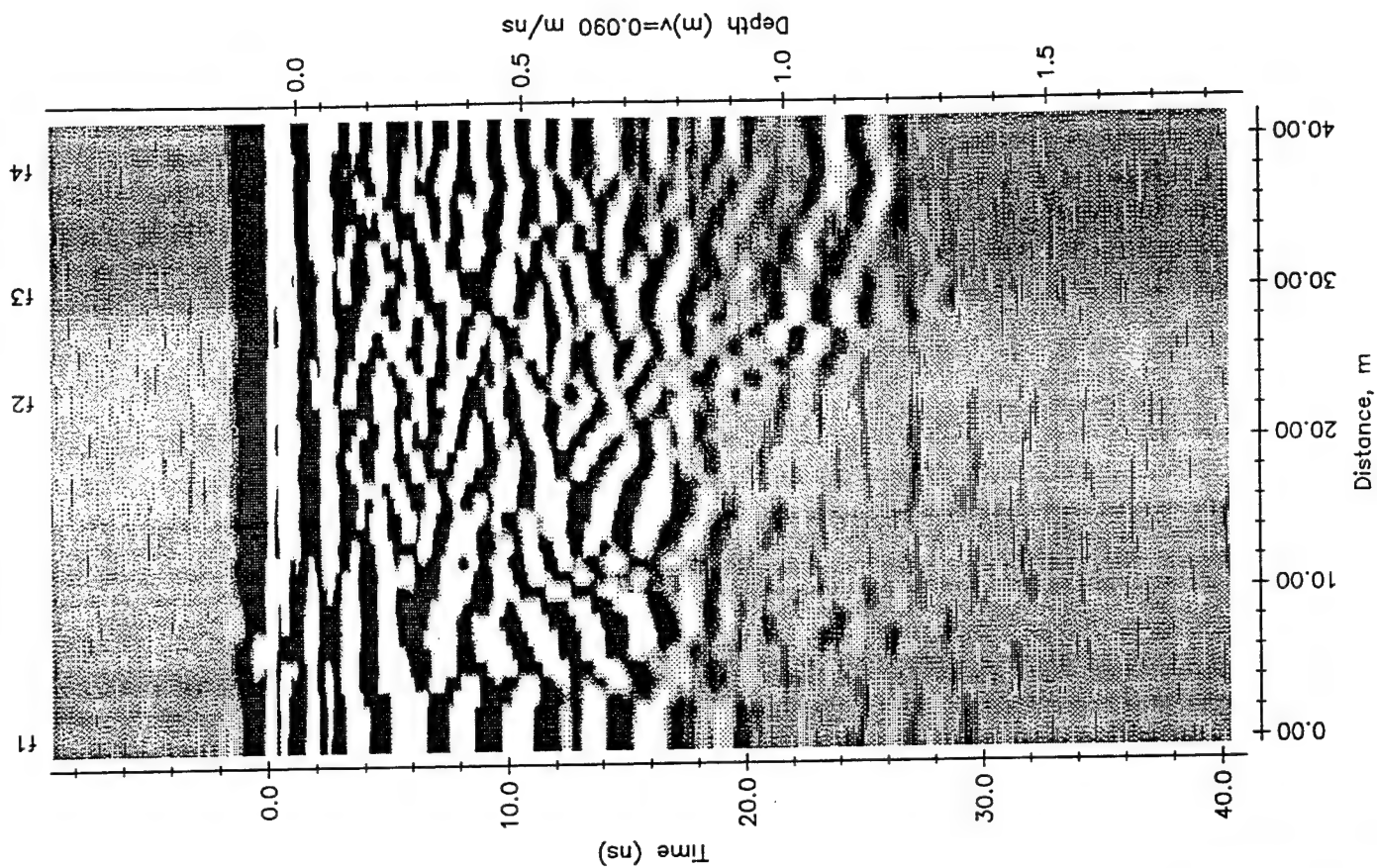
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 FILE = s:\COASTG~1\20SEP0~1\CG9000PP2  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Powdered Gypsum Pile, 900 MHz, Pipe - Profile Over Pipe  
 DATE = 20/09/10  
 NUMBER OF TRACES = 42  
 NUMBER OF PTS/TRC = 1000  
 TIMEZERO AT POINT = 193  
 TOTAL TIME WINDOW = 50  
 STARTING POSITION = 0.000  
 FINAL POSITION = 41.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 900.00  
 ANTENNA SEPARATION = 0.170  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971258/59

#### PROCESSING SELECTED

FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -9 to 41  
 SELECTION  
 POSITIONS: 0.000 to 41.000  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

#### PLOT LAYOUT PARAMETERS

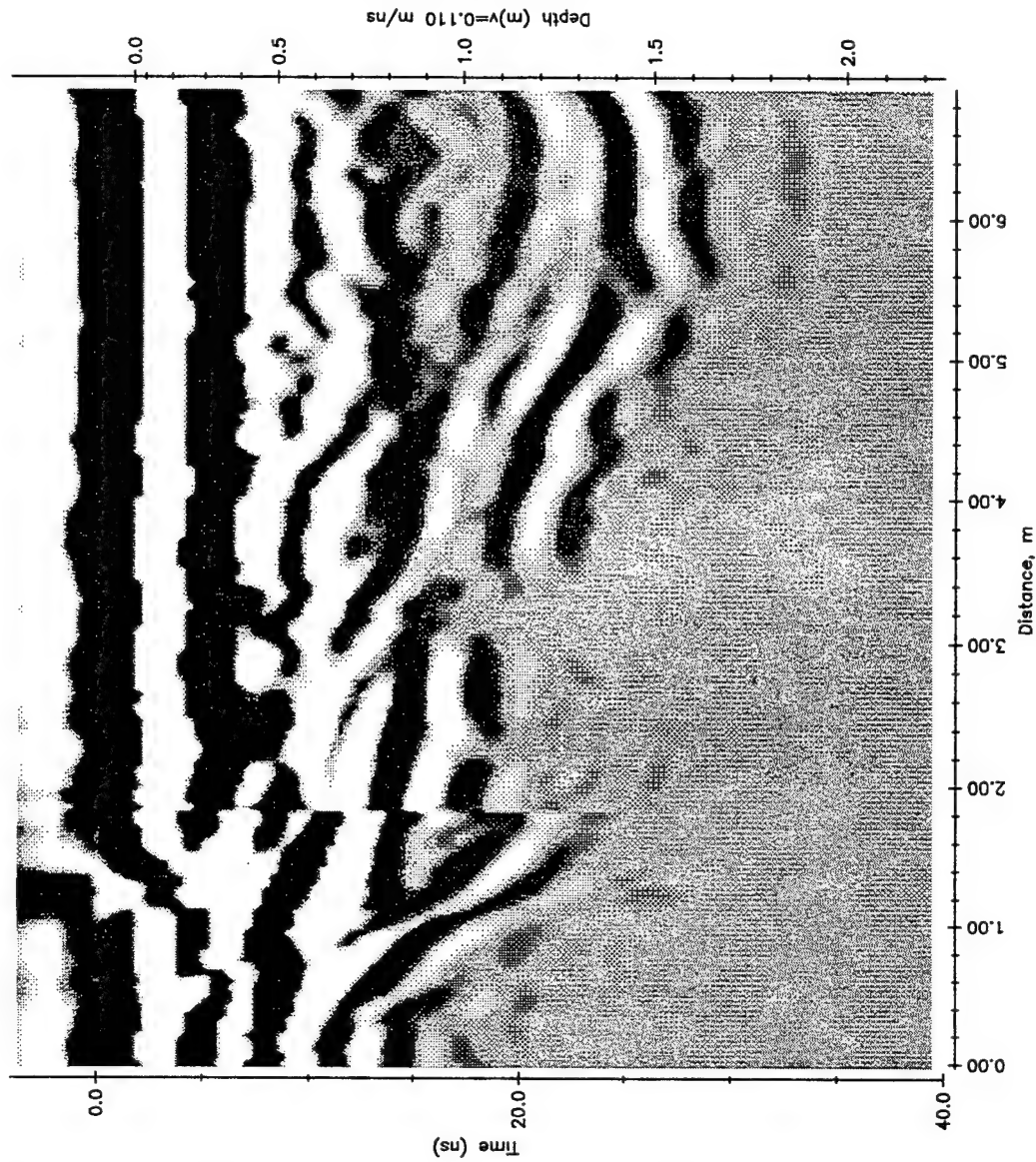
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 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\20SEPO~1\CG250PP0  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Powered Gypsum Pile, 250 MHz, Pipe - West Edge of Pile  
 DATE = 09/20/20  
 NUMBER OF TRACES = 139  
 NUMBER OF PTS/TRC = 111  
 TIMEZERO AT POINT = 11  
 TOTAL TIME WINDOW = 44  
 STARTING POSITION = 0.000  
 FINAL POSITION = 6.900  
 STEP SIZE USED = 0.050  
 POSITION UNITS = m  
 NOMINAL FREQUENCY = 250.00  
 ANTENNA SEPARATION = 0.305  
 PULSER VOLTAGE = 100  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection

PROCESSING SELECTED  
 FILTERS: TRACE STACKING: 1  
 POINT STACKING: 5  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 SELECTION TIME: -4 to 40  
 POSITIONS: 0.000 to 6.900  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

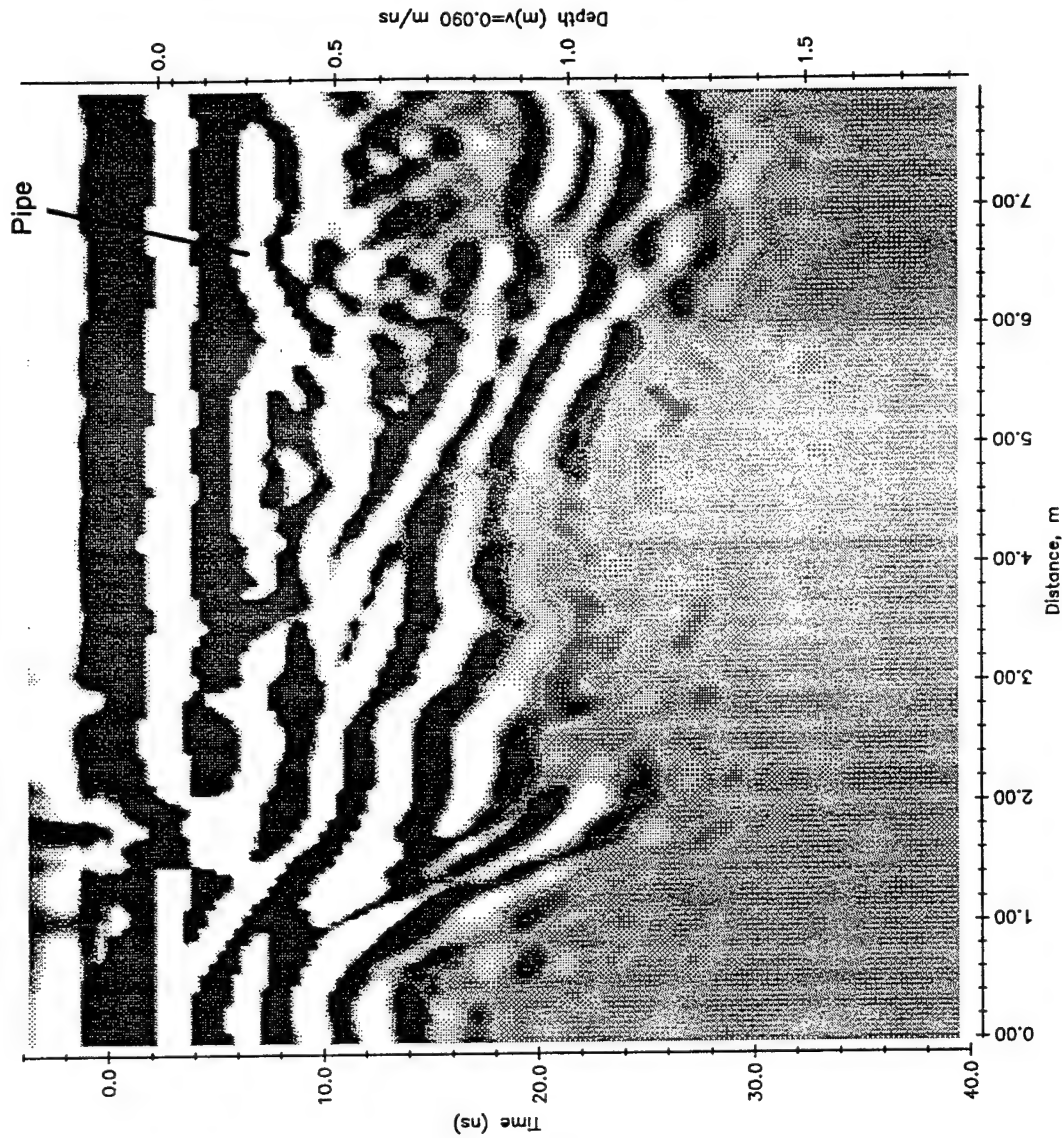
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 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name: GREY Type: EA Expansion: 0.500 Contour: 0



pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\20SEP0~1\CG250PP1  
 JOB# =  
 TITLE = Alabama Shipyard, Bulk Handling Area  
 TITLE = Powdered Gypsum Pile, 250 MHz, Pipe - West Edge of Pipe  
 DATE = 09/20/20  
 NUMBER OF TRACES = 160  
 NUMBER OF PTS/TRC = 111  
 TIMEZERO AT POINT = 11  
 TOTAL TIME WINDOW = 44  
 STARTING POSITION = 0.000  
 FINAL POSITION = 7.950  
 STEP SIZE USED = 0.050  
 POSITION UNITS = m  
 NOMINAL FREQUENCY = 250.00  
 ANTENNA SEPARATION = 0.305  
 PULSER VOLTAGE = 100  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection

PROCESSING SELECTED  
 FILTERS: TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 SELECTION TIME: -4 to 40  
 POSITIONS: 0.000 to 7.950  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.0500 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0

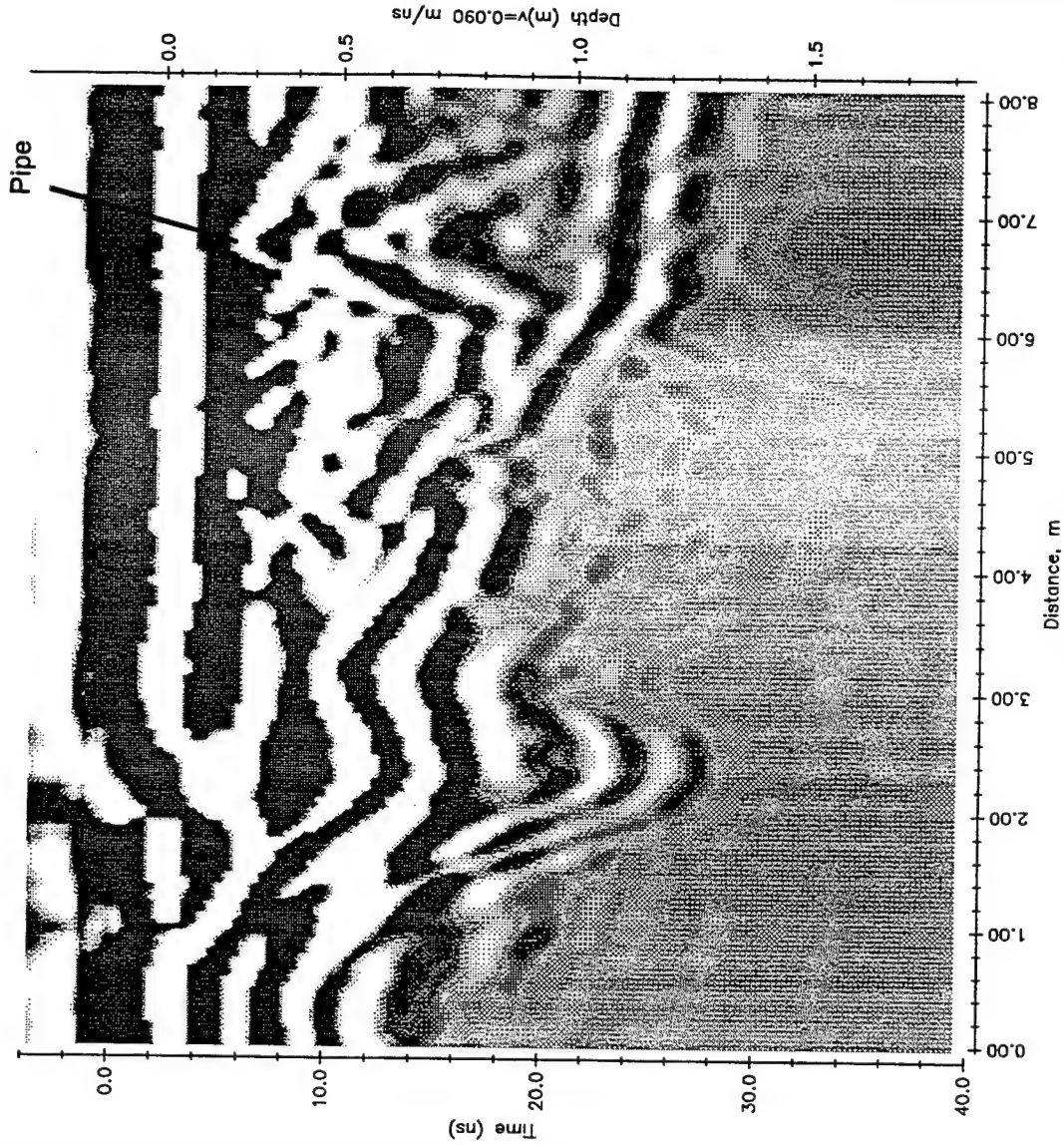




pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\20SEP0~1\CG250PP2  
 JOB# =  
 TITLE = Alabama Shipyard, Bulk Handling Area  
 DATE = 09/20/20  
 NUMBER OF TRACES = 162  
 NUMBER OF PTS/TRC = 111  
 TIMEZERO AT POINT = 44  
 TOTAL TIME WINDOW = 0.000  
 STARTING POSITION = 8.050  
 FINAL POSITION = 0.050  
 STEP SIZE USED = m  
 POSITION UNITS = 250.00  
 NOMINAL FREQUENCY = 0.305  
 ANTENNA SEPARATION = 100  
 PULSER VOLTAGE = 16  
 NUMBER OF STACKS = Reflection  
 SURVEY MODE =

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -4 to 40  
 SELECTION  
 POSITIONS: 0.000 to 8.050  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

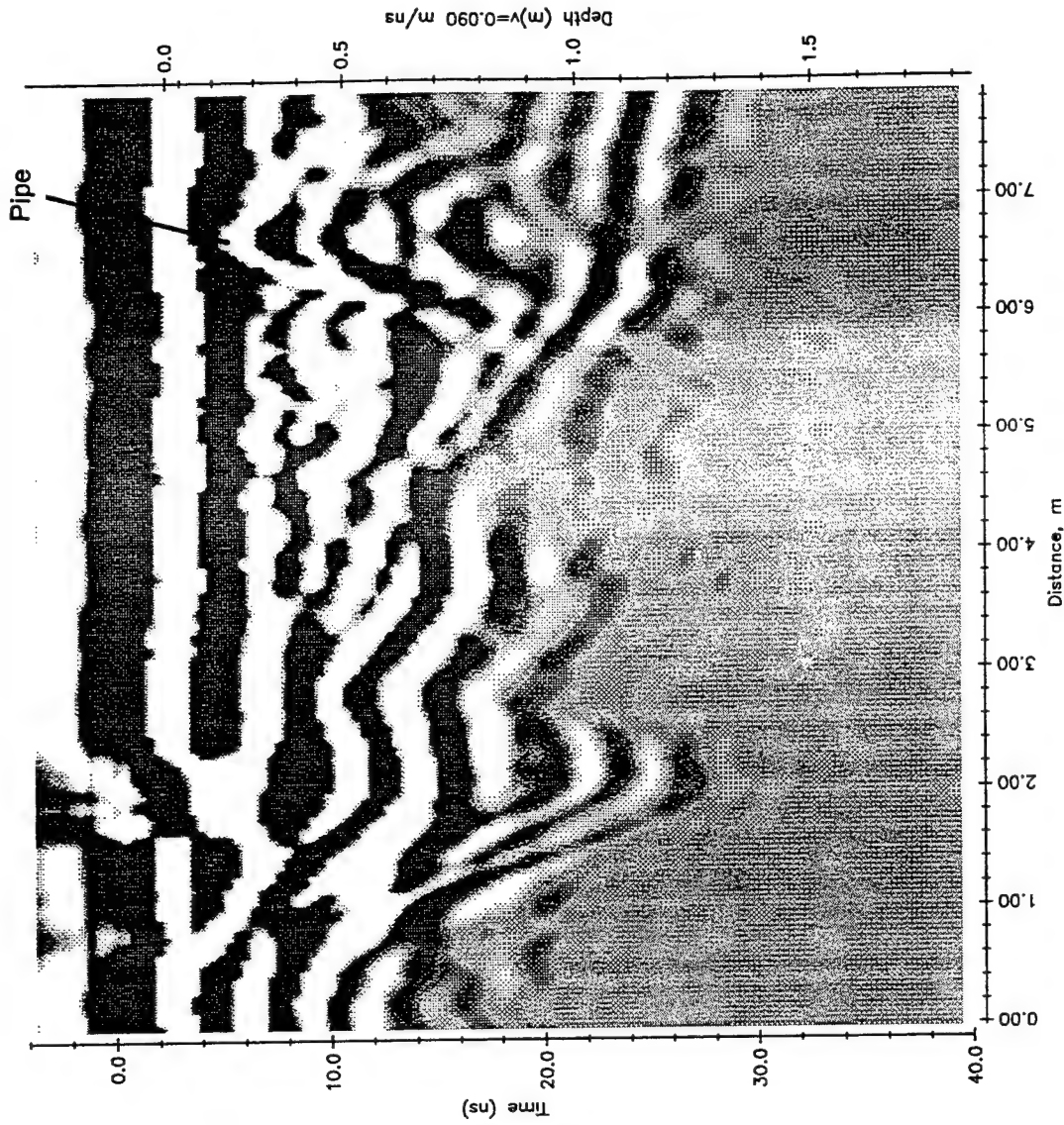
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 BORDER SIZE: 0.000  
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 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\20SEPO~1\CG250PP3  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Powdered Gypsum Pile, 250 MHz, Pipe - Profile Over Pipe  
 DATE = 09/20/20  
 NUMBER OF TRACES = 158  
 NUMBER OF PTS/TRC = 111  
 TIMEZERO AT POINT = 11  
 TOTAL TIME WINDOW = 44  
 STARTING POSITION = 0.000  
 FINAL POSITION = 7.850  
 STEP SIZE USED = 0.050  
 POSITION UNITS = m  
 NOMINAL FREQUENCY = 250.00  
 ANTENNA SEPARATION = 0.305  
 PULSER VOLTAGE = 100  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -4 to 40  
 SELECTION  
 POSITIONS: 0.000 to 7.850  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

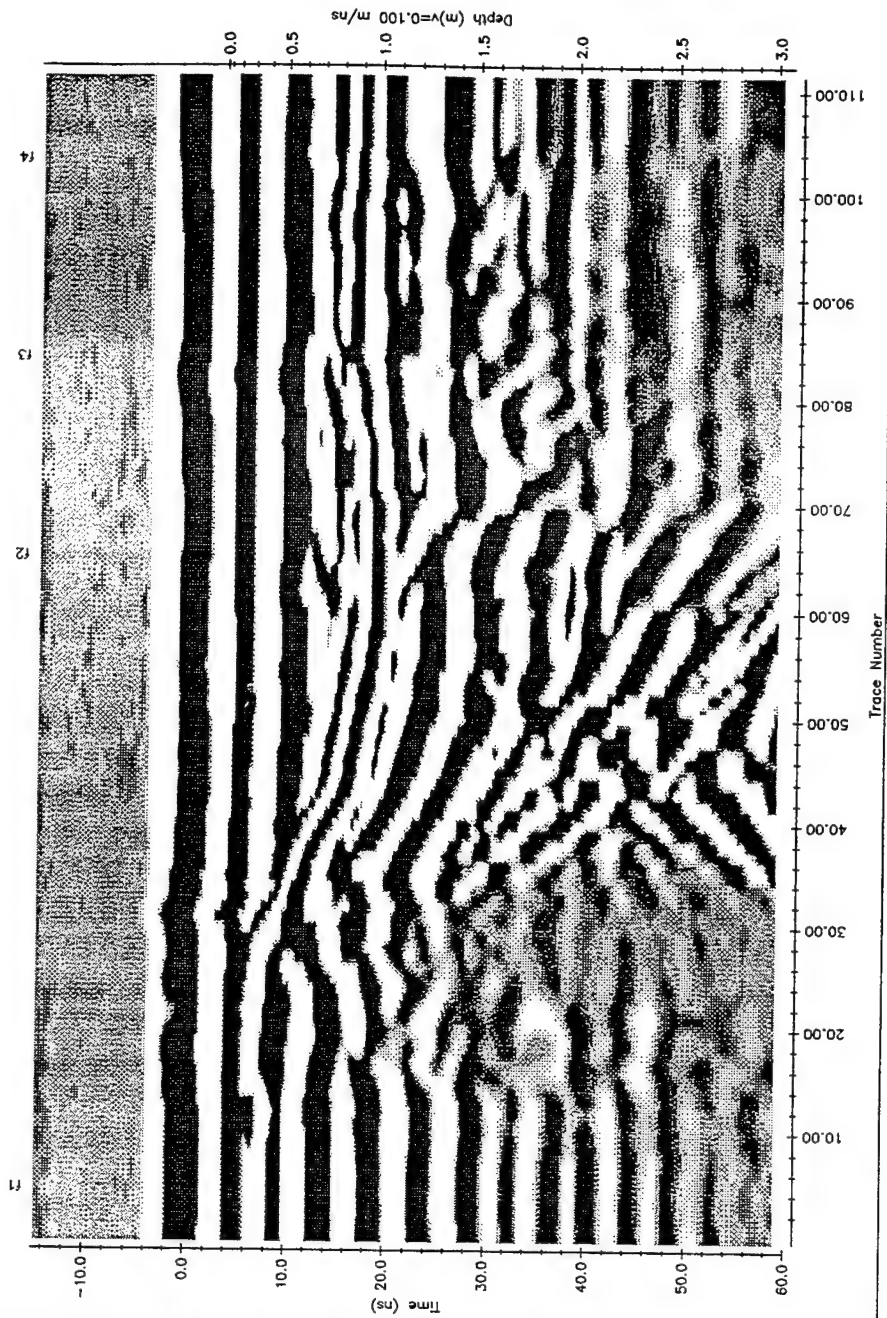
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 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



**Appendix C**  
**Crushed Pumice**  
**GPR Records - Initial Investigation**

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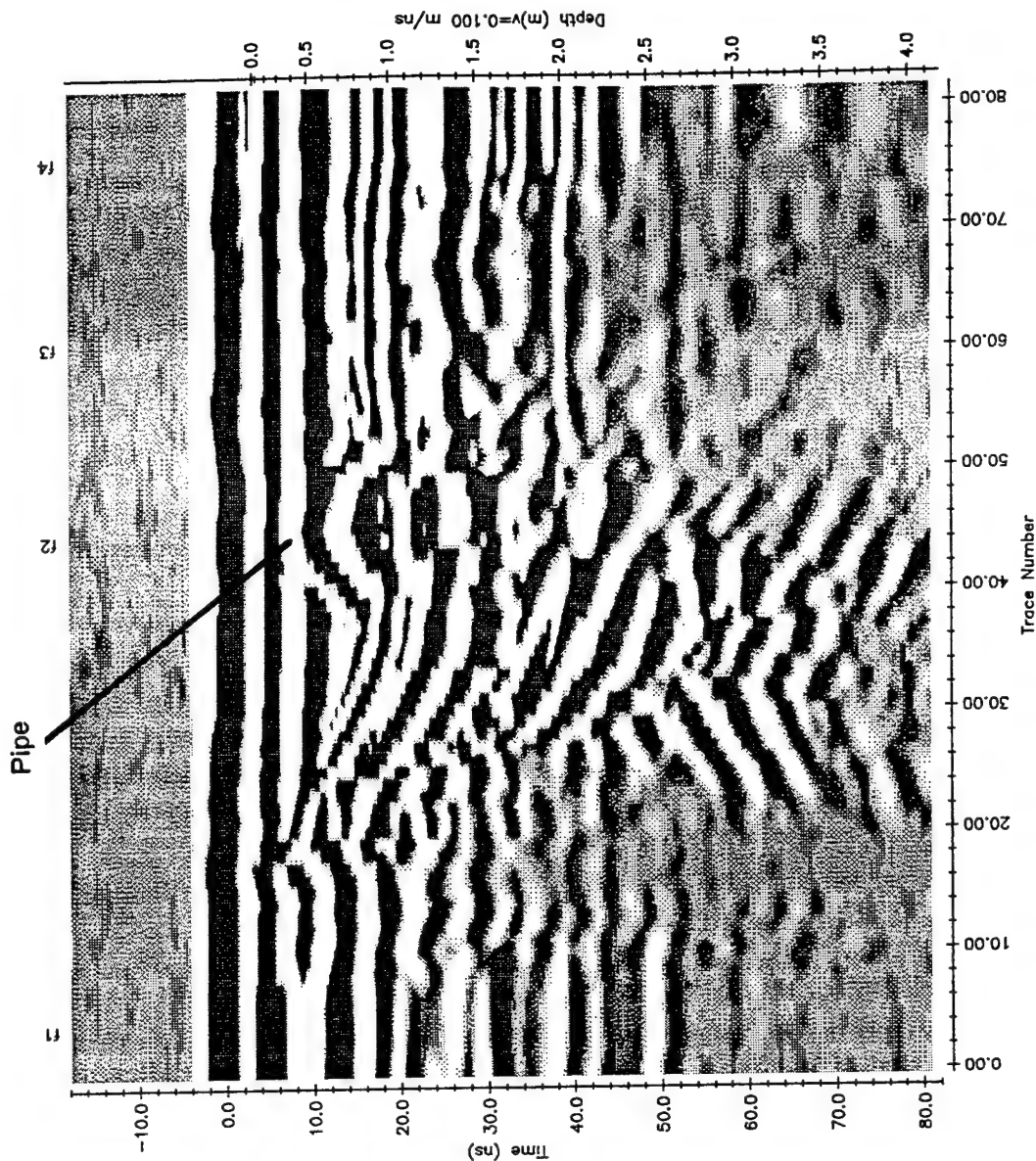
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 JOB # 1  
 TITLE 1  
 DATE 20/09/10  
 NUMBER OF PIS/TRC 112  
 NUMBER OF PIS/TRC 250  
 TOTAL TIME 53  
 TOTAL TIME 75000  
 STARTING POSITION 111.000  
 FINAL POSITION 1.000  
 STEP SIZE USED 1.000  
 POSITION UNITS metres  
 NOMINAL FREQUENCY 225.00  
 ANTENNA SEPARATION 0.500  
 PULSER VOLTAGE 200  
 SURVEY MODE 16  
 REFLECTION 16  
 COLLECTED BY PE1000 - Con: 981119, RX: 981120  
 TX: 981121 ANT: 971195/98  
 PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT DIFFERENCING: 2  
 CORRECTION: DEWOW  
 TIME: 10.000  
 SELECTION POSITIONS: 0.000 to 111.000  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000  
 PLOT LAYOUT PARAMETERS  
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 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseKHO HEADER PARAMETERS  
 FILE = s:\COASTG~1\205EP0~1\CG225MP2  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Pumice Pile, 225 MHz, Pipe - Profile Over Pipe  
 DATE = 20/09/10  
 NUMBER OF TRACES = 82  
 NUMBER OF PTS/TRC = 333  
 TIMEZERO AT POINT = 63  
 TOTAL TIME WINDOW = 100  
 STARTING POSITION = 0.000  
 FINAL POSITION = 81.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 225.00  
 ANTENNA SEPARATION = 0.500  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971195/96

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -18 to 82  
 SELECTION POSITIONS: 0.000 to 81.000  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS  
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 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
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 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
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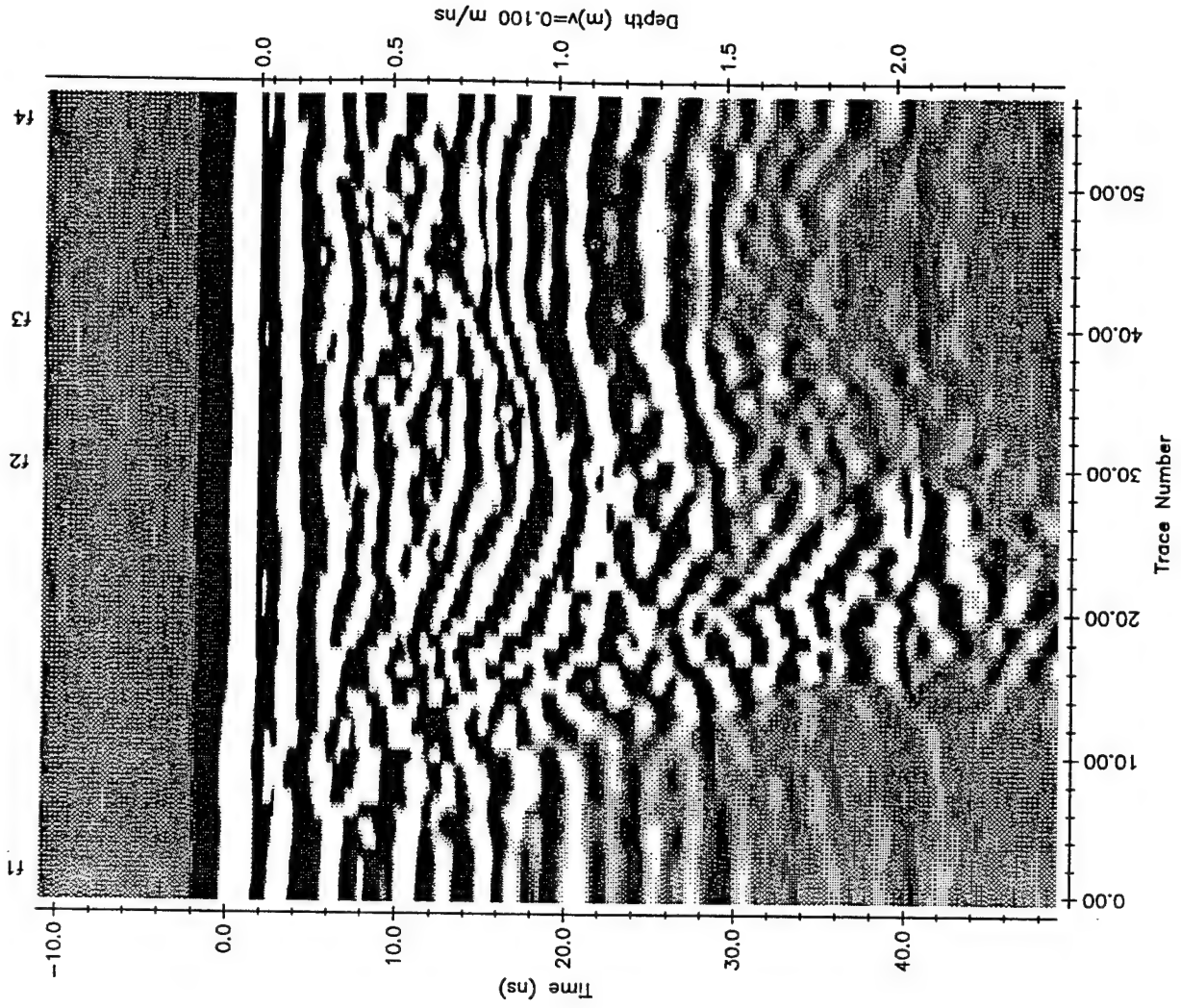




pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\20SEP0~1\CG450MP1  
 JOB# =  
 TITLE = Alabama Shipyard, Bulk Handling Area  
 TITLE = Pumice Pile, 450 MHz, Pipe - West Edge of Pile  
 DATE = 20/09/10  
 NUMBER OF TRACES = 57  
 NUMBER OF PTS/TRC = 600  
 TIMEZERO AT POINT = 110  
 TOTAL TIME WINDOW = 60  
 STARTING POSITION = 0.000  
 FINAL POSITION = 56.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 450.00  
 ANTENNA SEPARATION = 0.250  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971181/82

PROCESSING SELECTED  
 FILTERS: TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -11 to 49  
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 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

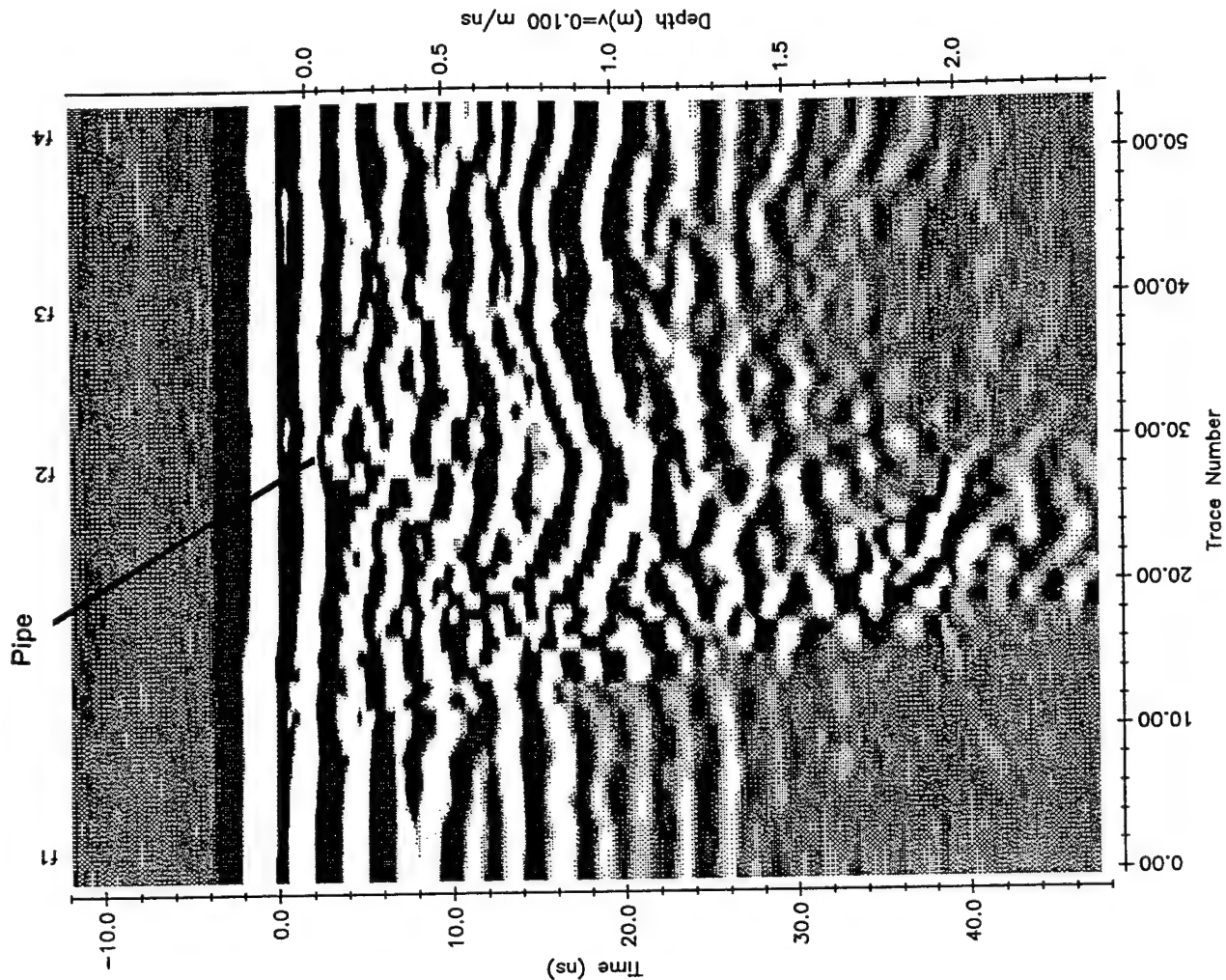
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 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\20SEPO~1\CG450MP2  
 JOB# =  
 TITLE = Alabama Shipyard, Bulk Handling Area  
 TITLE = Pumice Pile, 450 MHz, Pipe - Profile Over Pipe  
 DATE = 20/09/10  
 NUMBER OF TRACES = 54  
 NUMBER OF PTS/TRC = 600  
 TIMEZERO AT POINT = 126  
 TOTAL TIME WINDOW = 60  
 STARTING POSITION = 0.000  
 FINAL POSITION = 53.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 450.00  
 ANTENNA SEPARATION = 0.250  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971181/82

PROCESSING SELECTED  
 FILTERS: TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
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 TIME: -12 to 48  
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 MULTIPLIER: 100.000

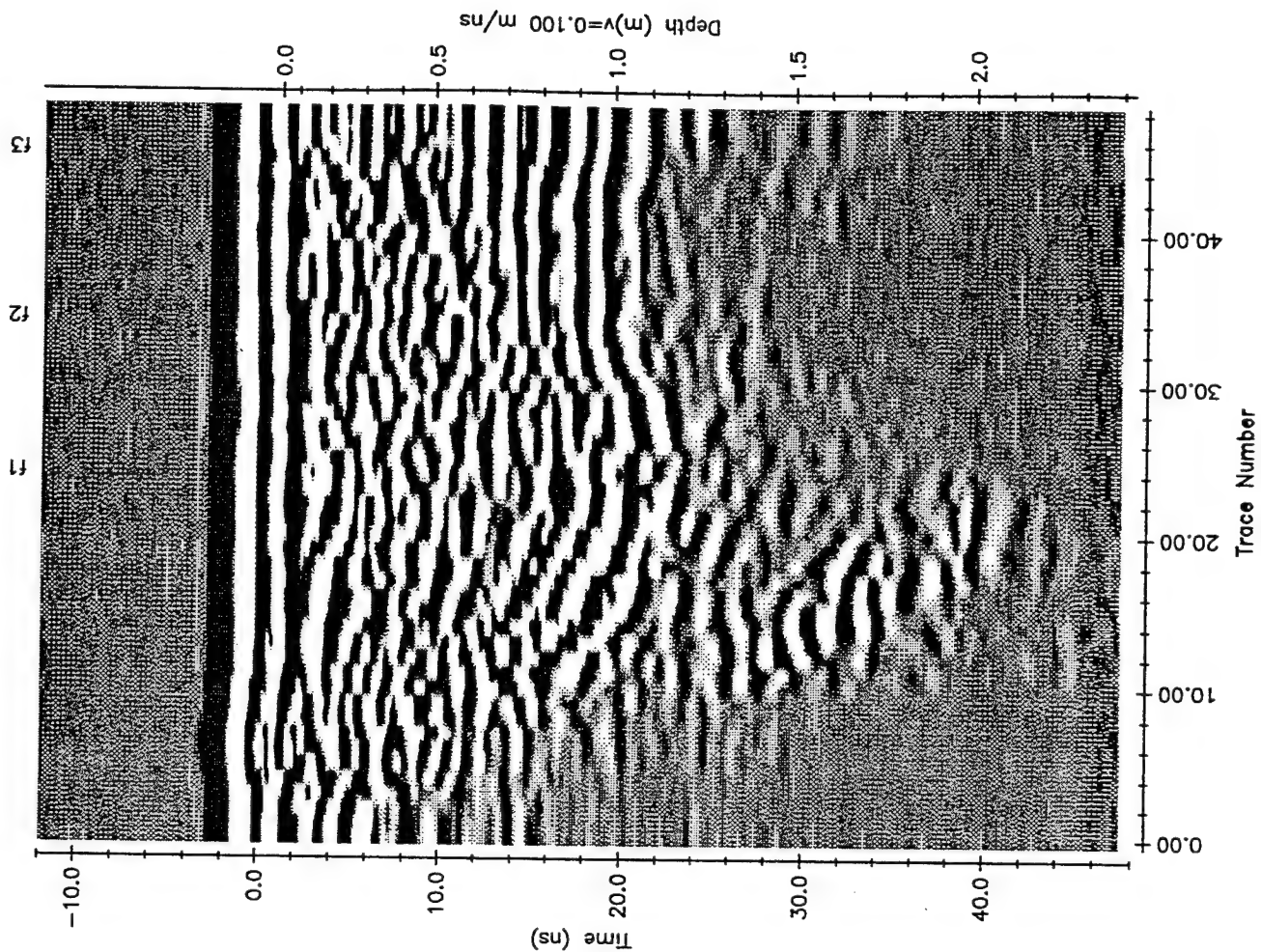
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 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\20SEP0~1\CG9000MP1  
 JOB# =  
 TITLE = Alabama Shipyard, Bulk Handling Area  
 DATE = 20/09/10  
 NUMBER OF TRACES = 49  
 NUMBER OF PTS/TRC = 600  
 TIMEZERO AT POINT = 126  
 TOTAL TIME WINDOW = 60  
 STARTING POSITION = 0.000  
 FINAL POSITION = 48.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 900.00  
 ANTENNA SEPARATION = 0.170  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971258/59

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -12 to 48  
 POSITIONS: 0.000 to 48.000  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS  
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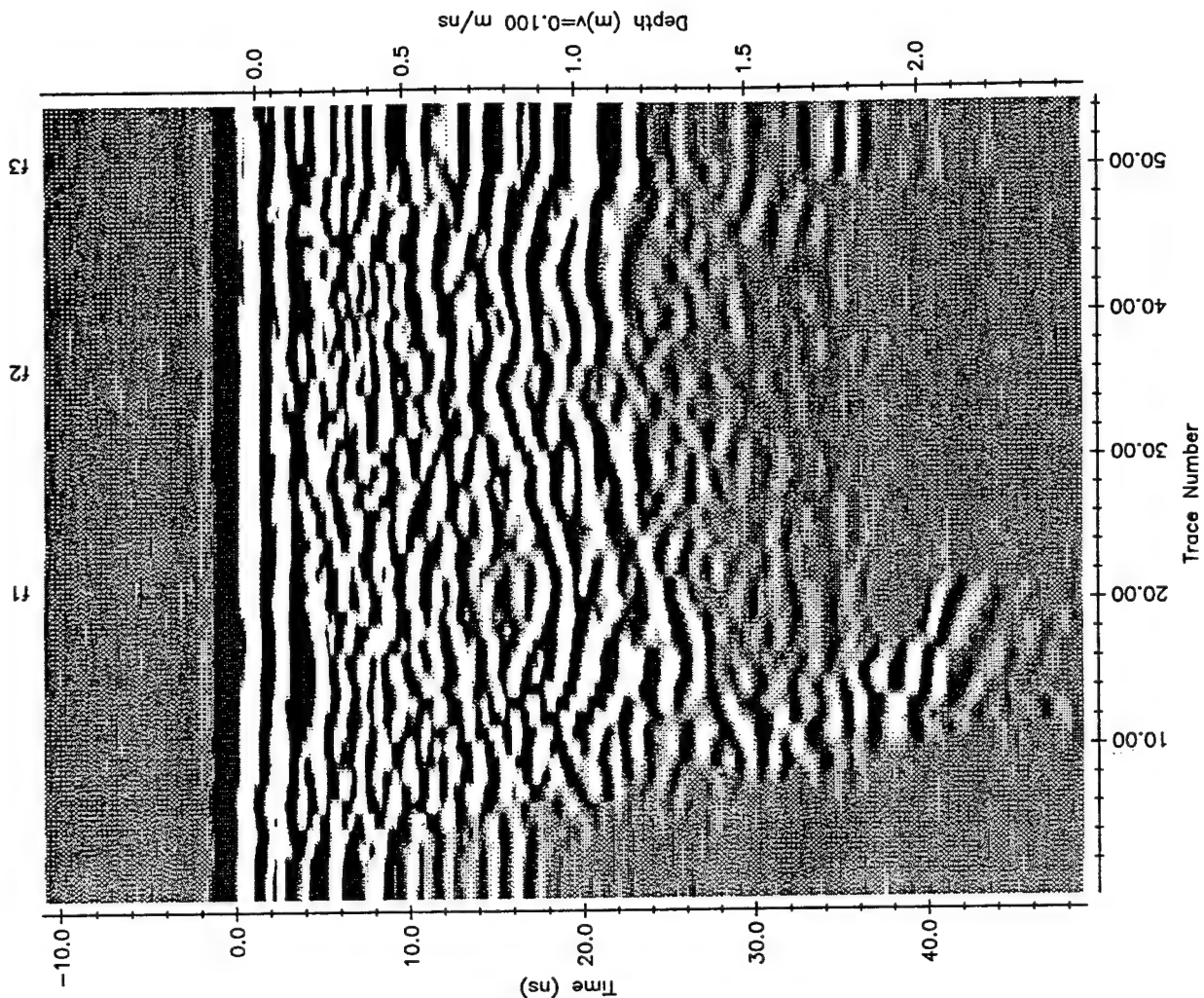




pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\20SEP0~1\CG900MP2  
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 TITLE = Pumice Pile, 900 MHz, Pipe - Profile Over Pipe  
 DATE = 20/09/10  
 NUMBER OF TRACES = 55  
 NUMBER OF PTS/TRC = 600  
 TIMEZERO AT POINT = 111  
 TOTAL TIME WINDOW = 60  
 STARTING POSITION = 0.000  
 FINAL POSITION = 54.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 900.00  
 ANTENNA SEPARATION = 0.170  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971258/59

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
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 SELECTION  
 POSITIONS: 0.000 to 54.000  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

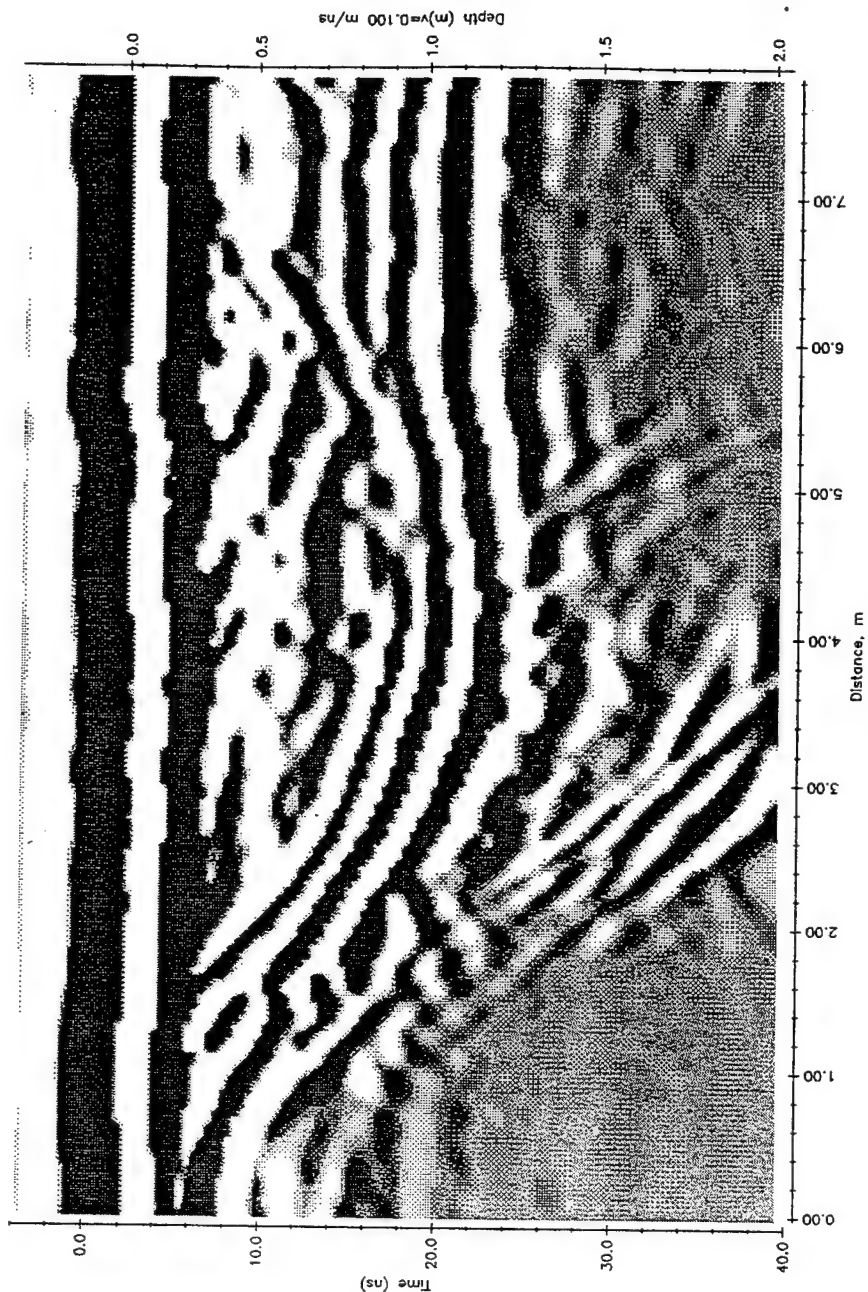
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pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG-1\20SEP0-1\CG250MPO  
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 TITLE = Purnice Pile, 250 Mhz, Pipe - West Edge of Pile  
 DATE = 09/20/20  
 NUMBER OF TRACES = 157  
 NUMBER OF PTS/TRC = 111  
 TIME ZERO A POINT = 11  
 TIME ZERO WINDOW = 4400  
 STARTING POSITION = 0.000  
 FINAL POSITION = 0.050  
 STEP SIZE USED = 250.00  
 POSITION UNITS = 0.305  
 NOMINAL FREQUENCY = 250.00  
 ANTENNA SEPARATION = 100  
 PULSER VOLTAGE = 16  
 NUMBER OF STACKS = Reflection  
 SURVEY MODE =

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -4 to 40  
 SELECTION POSITIONS: 0.000 to 7.800  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

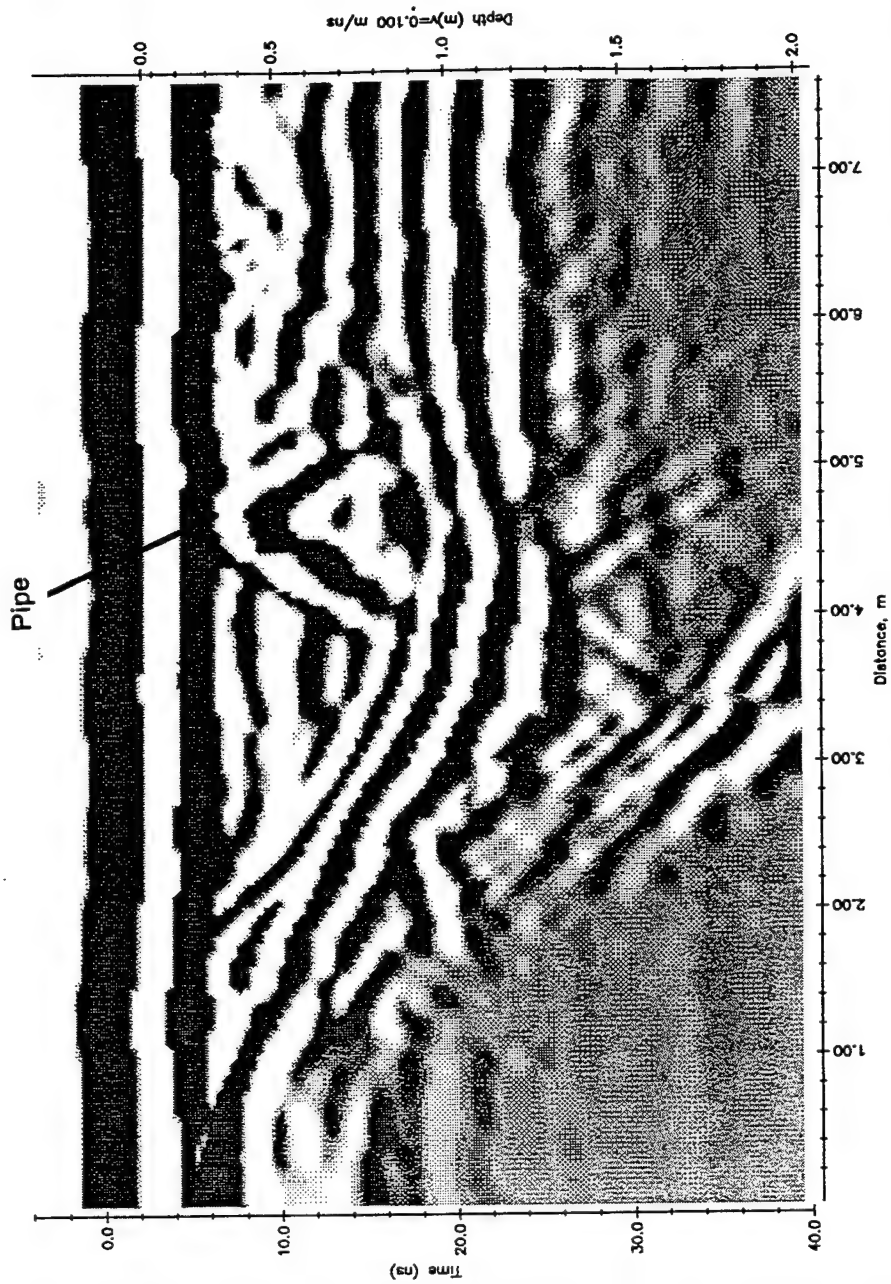
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 FILE = 9\COASTG-1\20SEP0-1\CG250MP1  
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 TITLE = Alabama Shipyard, Bulk Handling Area  
 TITLE = Puntica Pile, 250 MHz, Pipe - Profile Over Pipe  
 DATE = 09/20/20  
 NUMBER OF TRACES = 153  
 NUMBER OF PTS/TRC = 111  
 TIMEZERO AT POINT = 44  
 TOTAL TIME WINDOW = 9.000  
 STARTING POSITION = 0.000  
 FINAL POSITION = 0.050  
 PILE SIZE (IN) = 6.000  
 POSITION UNITS =  
 NOMINAL FREQUENCY = 250.00  
 ANTENNA SEPARATION = 0.305  
 PULSER VOLTAGE = 100  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 1  
 PAPER REPRESENTING: N  
 CORRECTION: DEWOW  
 TIME: 4 to 40  
 SELECTION POSITIONS: 0.000 to 7.600  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.0750 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



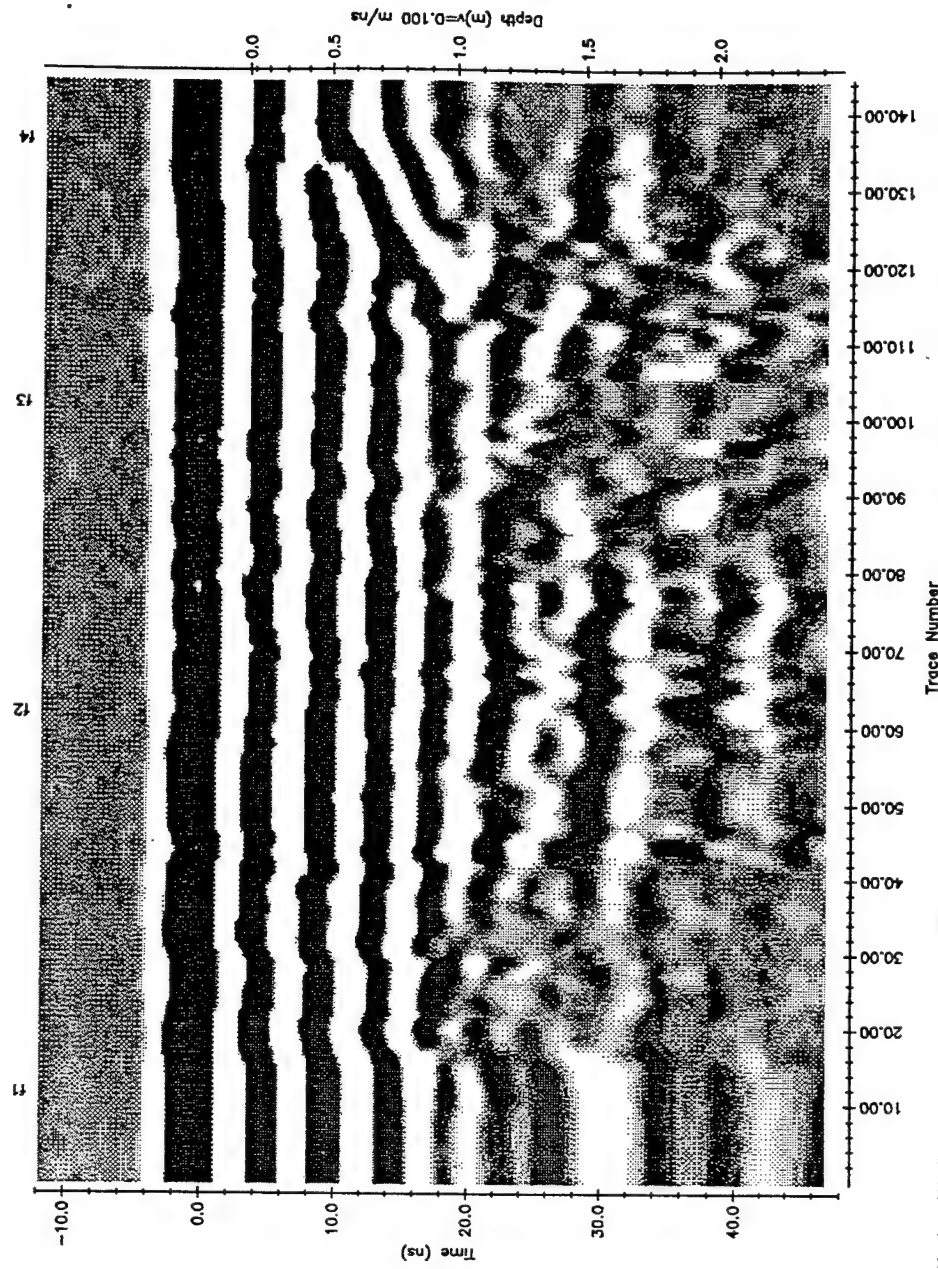
**Appendix D  
Coarse Coal  
GPR Records - Initial Investigation**

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pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\205EPO~1\CG225CP1  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Coal (coarse) Pile, 225 MHz, Pipe -- North Edge of Pipe  
 DATE = 20/09/10  
 NUMBER OF TRACES = 145  
 NUMBER OF PIS/TRC = 200  
 TIMEZERO AT POINT = 43  
 TIMEZONE WINDOW = 60  
 STARTING POSITION = 0.000  
 FINAL POSITION = 144.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = meters  
 NOMINAL FREQUENCY = 225.00  
 ANTENNA SEPARATION = 0.500  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971195/96

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -12 to 48  
 POSITION: 0.000 to 144.000  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

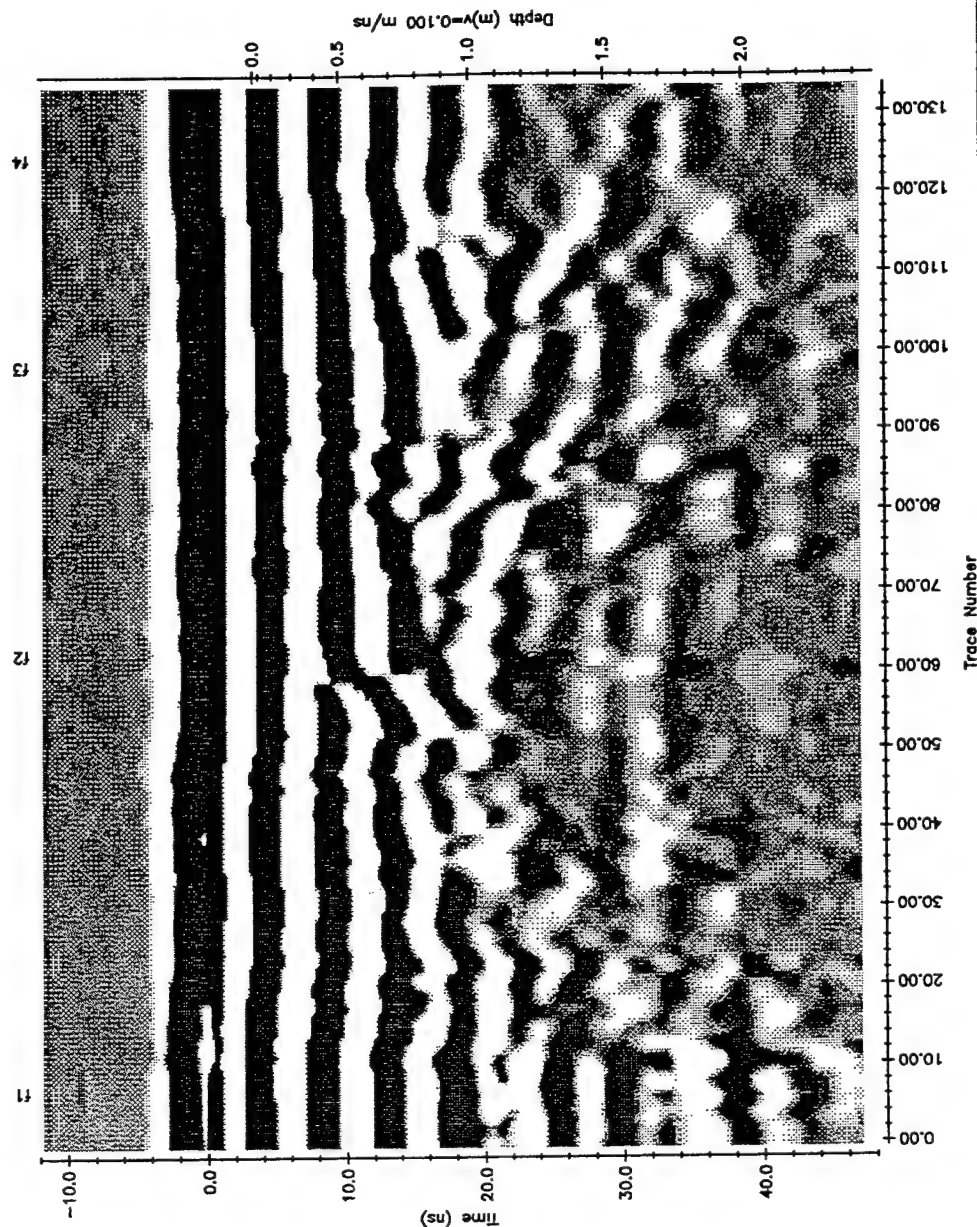
PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.0750 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\20SEP0~1\CG225CP2  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Coal (coarse) Pipe, 225 MHz, Pipe - Profile Over Pipe  
 DATE = 20/09/10  
 NUMBER OF TRACES = 134  
 NUMBER OF PTS/TRC = 200  
 TIMEZERO AT POINT = 43  
 TOTAL TIME WINDOW = 60  
 STARTING POSITION = 0.000  
 FINAL POSITION = 133.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 225.00  
 ANTENNA SEPARATION = 0.500  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971195/96

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 SELECTION  
 TIME: -12 to 48  
 POSITIONS: 0.000 to 133.000  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.0750 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE NUMBER: 10.000  
 BORDER SIZE: 0.000  
 PRINTER NAME: L35300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0

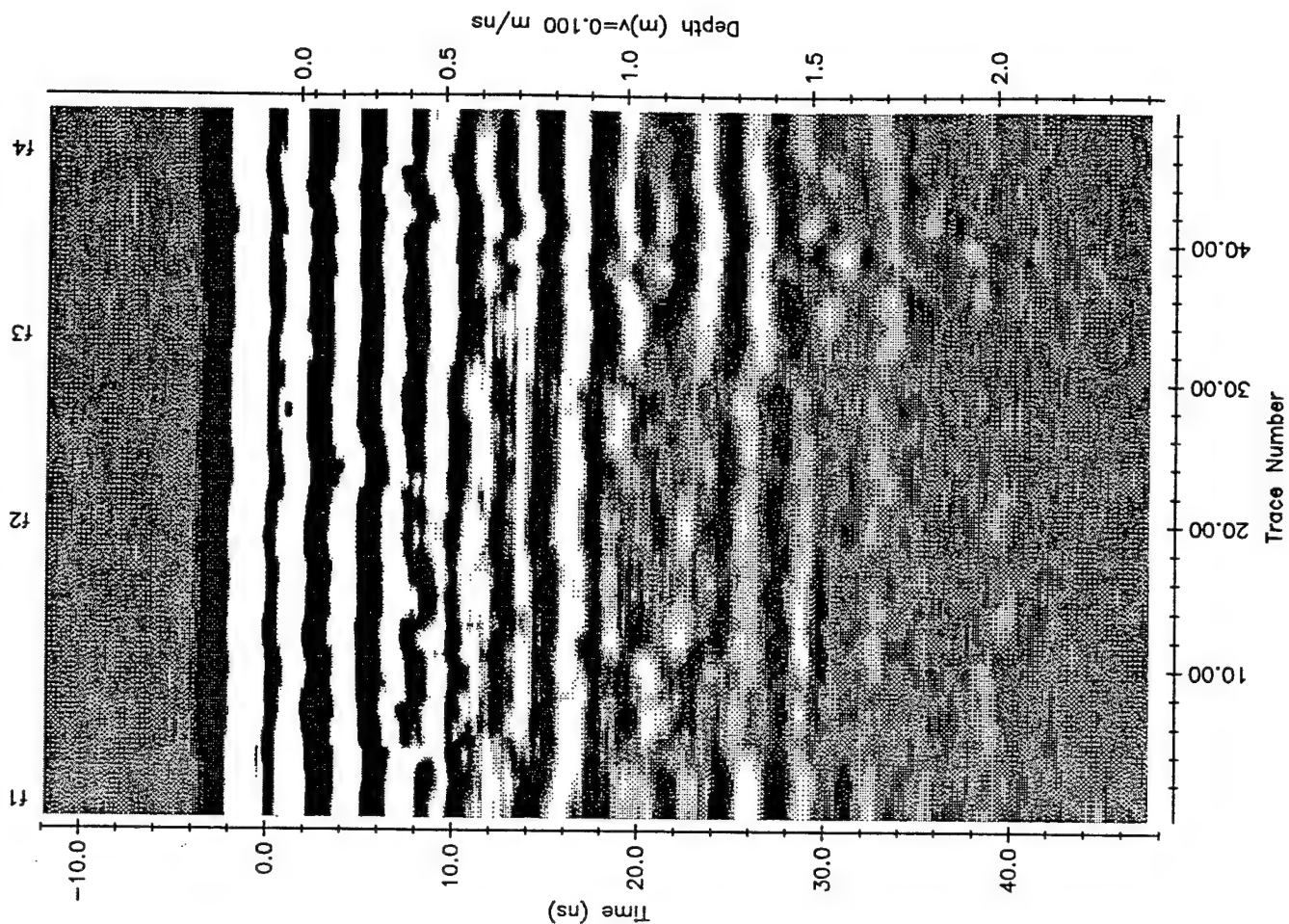




pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\20SEP0~1\CG450CP1  
 JOB# =  
 TITLE = Alabama Shipyard, Bulk Handling Area  
 DATE = 20/09/10  
 TIMEZERO AT POINT = 126  
 TOTAL TIME WINDOW = 60  
 STARTING POSITION = 0.000  
 FINAL POSITION = 49.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 450.00  
 ANTENNA SEPARATION = 0.250  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971181/82

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -12 to 48  
 SELECTION  
 POSITIONS: 0.000 to 49.000  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

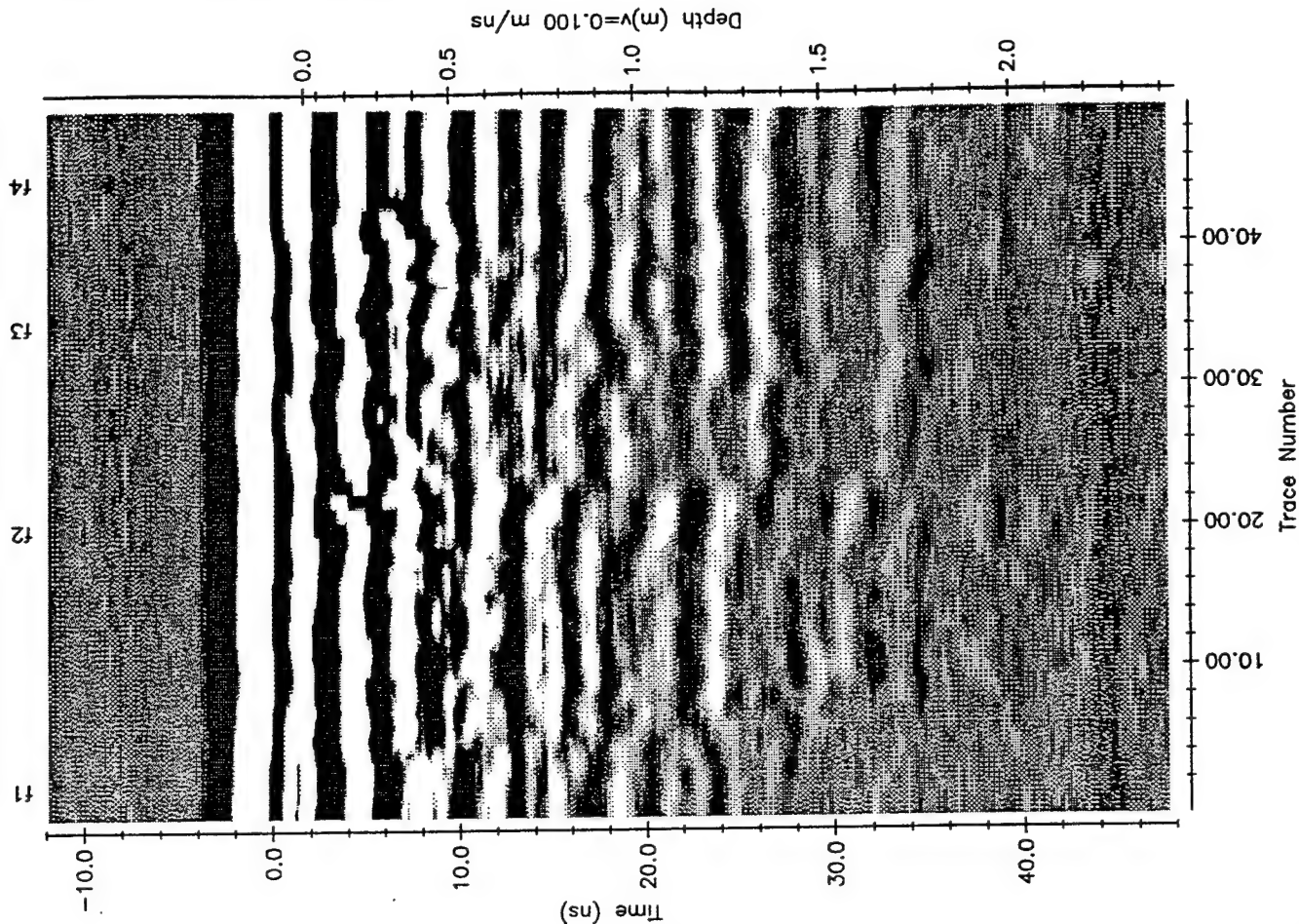
PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.1000 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\20SEP0~1\CG450CP2  
 JOB# =  
 TITLE = Alabama Shipyard, Bulk Handling Area , Profile Over Pipe  
 DATE = 20/09/10  
 NUMBER OF TRACES = 50  
 NUMBER OF PTS/TRC = 600  
 TIMEZERO AT POINT = 124  
 TOTAL TIME WINDOW = 60  
 STARTING POSITION = 0.000  
 FINAL POSITION = 49.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 450.00  
 ANTENNA SEPARATION = 0.250  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971181/82

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -12 to 48  
 SELECTION POSITIONS: 0.000 to 49.000  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

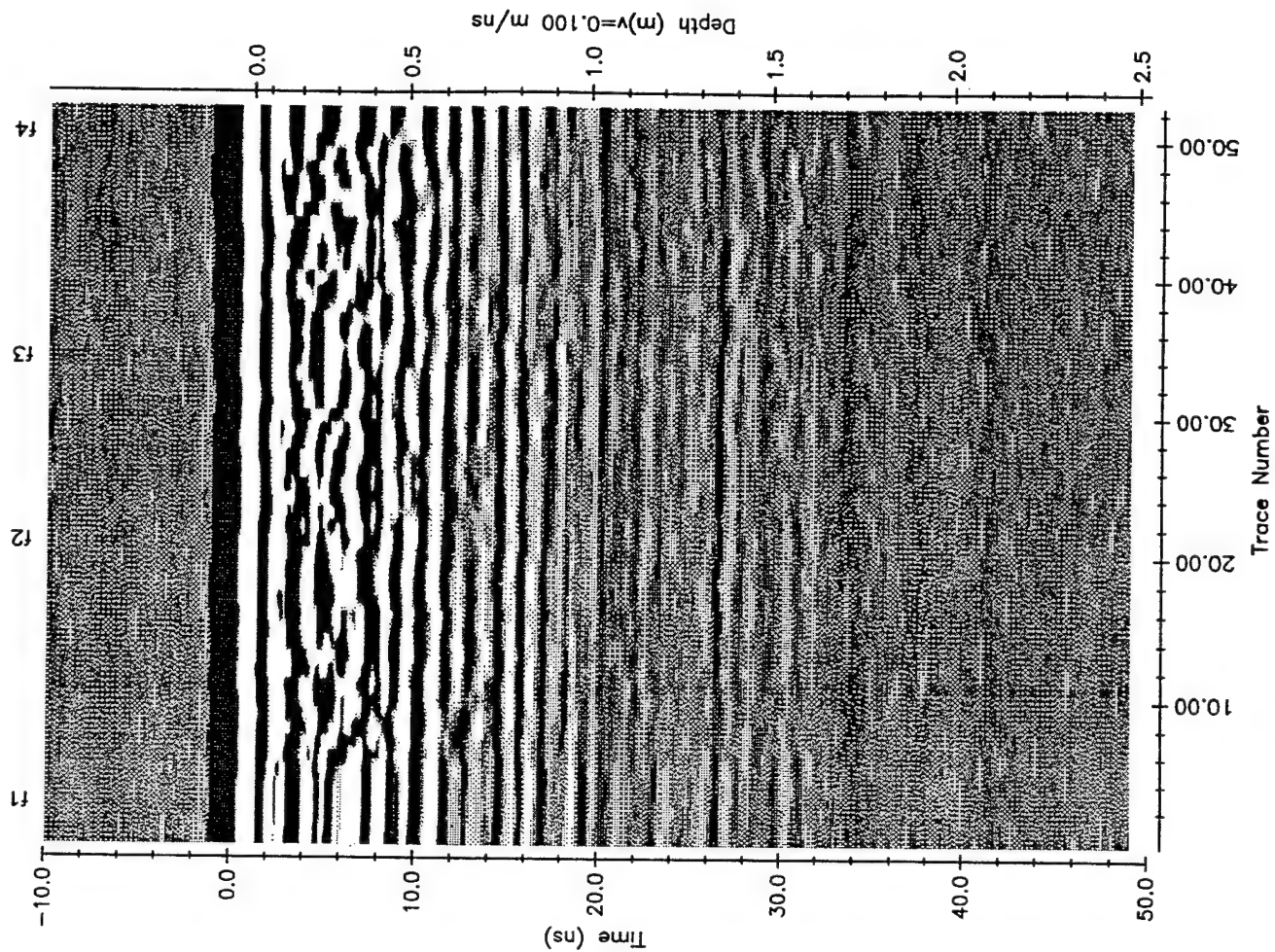
PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.1000 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\20SEP0~1\CG9000CP1  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Coal (Coarse) Pile, 900 MHz, Pipe - North Edge of Pile  
 DATE = 20/09/10  
 NUMBER OF TRACES = 53  
 NUMBER OF PTS/TRC = 600  
 TIMEZERO AT POINT = 109  
 TOTAL TIME WINDOW = 60  
 STARTING POSITION = 0.000  
 FINAL POSITION = 52.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 900.00  
 ANTENNA SEPARATION = 0.170  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971258/59

PROCESSING SELECTED  
 FILTERS: TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 SELECTION TIME: -10 to 50  
 POSITIONS: 0.000 to 52.000  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.1000 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



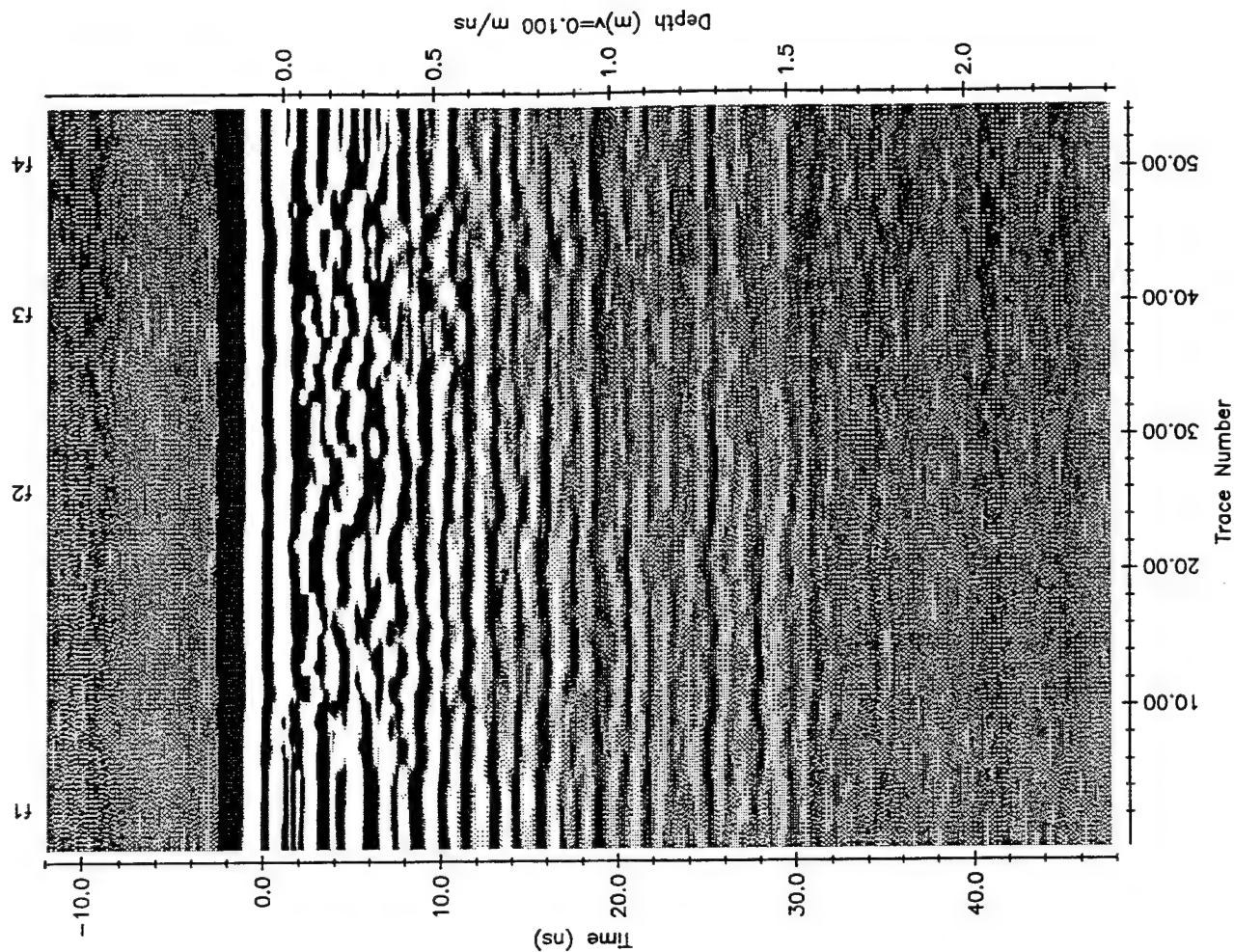
pulseKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\20SEP0~1\CG9000CP2  
 JOB# =  
 TITLE = Alabama Shipyard, Bulk Handling Area  
 TITLE = Coal (coarse) Pile, 900 MHz, Pipe - Profile Over Pipe  
 DATE = 20/09/10  
 NUMBER OF TRACES = 55  
 NUMBER OF PTS/TRC = 600  
 TIMEZERO AT POINT = 123  
 TOTAL TIME WINDOW = 60  
 STARTING POSITION = 0.000  
 FINAL POSITION = 54.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 900.00  
 ANTENNA SEPARATION = 0.170  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971258/59

#### PROCESSING SELECTED

FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -12 to 48  
 SELECTION  
 POSITIONS: 0.000 to 54.000  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

#### PLOT LAYOUT PARAMETERS

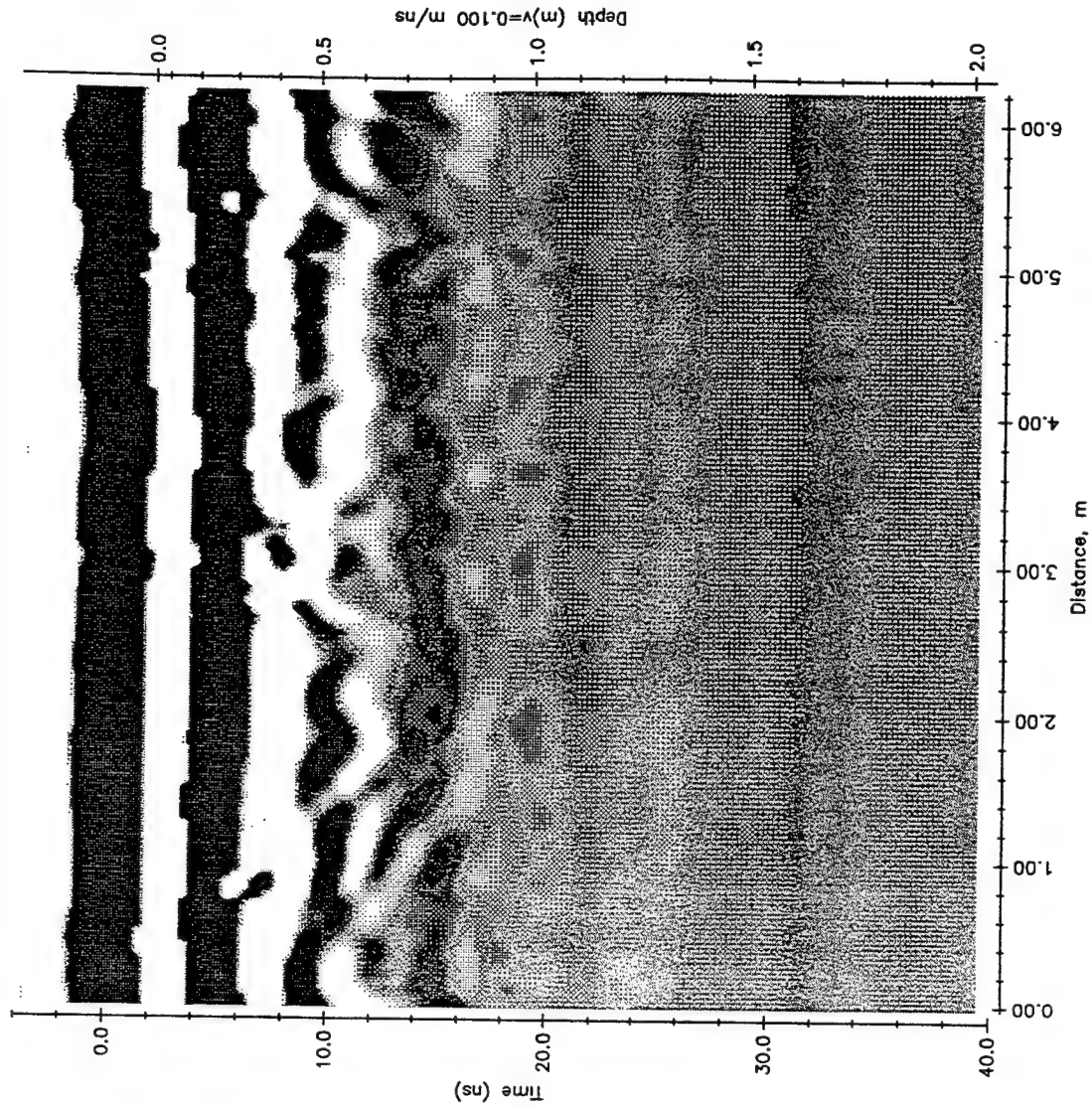
TRACE SPACING AND WIDTH: 0.1000 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



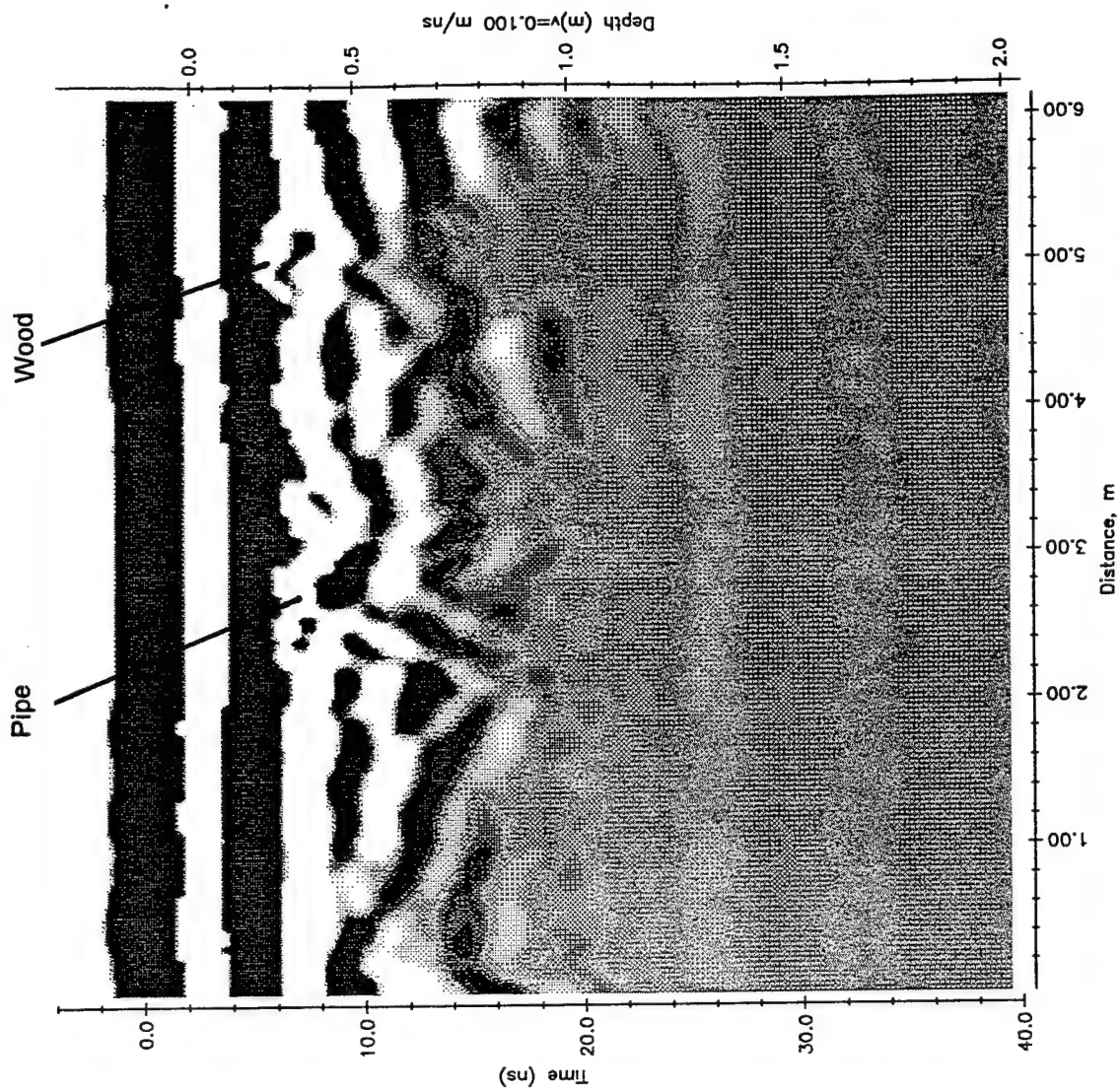


pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\20SEP0~1\CG250CP0  
 JOB# =  
 TITLE = Alabama Shipyard, Bulk Handling Area  
 DATE = 09/20/20  
 NUMBER OF TRACES = 125  
 NUMBER OF PTS/TRC = 111  
 TIMEZERO AT POINT = 11  
 TOTAL TIME WINDOW = 44  
 STARTING POSITION = 0.000  
 FINAL POSITION = 6.200  
 STEP SIZE USED = 0.050  
 POSITION UNITS = m  
 NOMINAL FREQUENCY = 250.00  
 ANTENNA SEPARATION = 0.305  
 PULSER VOLTAGE = 100  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 PROCESSING SELECTED  
 FILTERS: TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -4 to 40  
 SELECTION POSITIONS: 0.000 to 6.200  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.0600 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\20SEP0~1\CG250CP1  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Coal (coarse) Pile, 250 MHz, Pipe - Profile Over Pipe  
 DATE = 09/20/20  
 NUMBER OF TRACES = 123  
 NUMBER OF PTS/TRC = 111  
 TIMEZERO AT POINT = 11  
 TOTAL TIME WINDOW = 44  
 STARTING POSITION = 0.000  
 FINAL POSITION = 6.100  
 STEP SIZE USED = 0.050  
 POSITION UNITS = m  
 NOMINAL FREQUENCY = 250.00  
 ANTENNA SEPARATION = 0.305  
 PULSER VOLTAGE = 100  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 PROCESSING SELECTED  
 FILTERS: TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 SELECTION TIME: -4 to 40  
 POSITIONS: 0.000 to 6.100  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000  
 PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.0600 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0

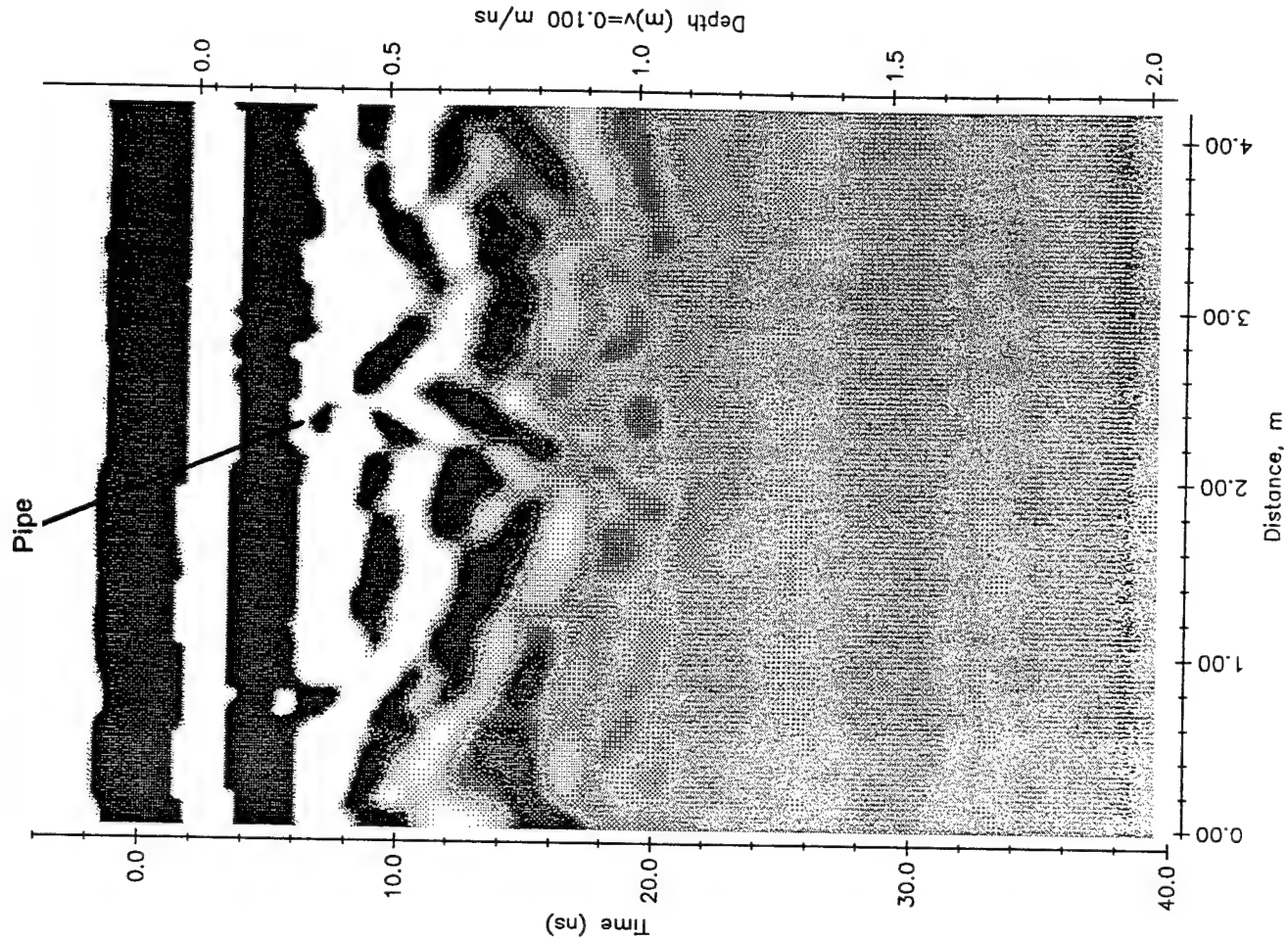




pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\20SEP0~1\CG250CP2  
 JOB# =  
 TITLE = Alabama Shipyard, Bulk Handling Area  
 DATE = 09/20/20  
 TIMEZERO AT POINT = 11  
 TOTAL TIME WINDOW = 44  
 STARTING POSITION = 0.000  
 FINAL POSITION = 4.150  
 STEP SIZE USED = 0.050  
 POSITION UNITS = m  
 NOMINAL FREQUENCY = 250.00  
 ANTENNA SEPARATION = 0.305  
 PULSER VOLTAGE = 100  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -4 to 40  
 SELECTION  
 POSITIONS: 0.000 to 4.150  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.0600 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



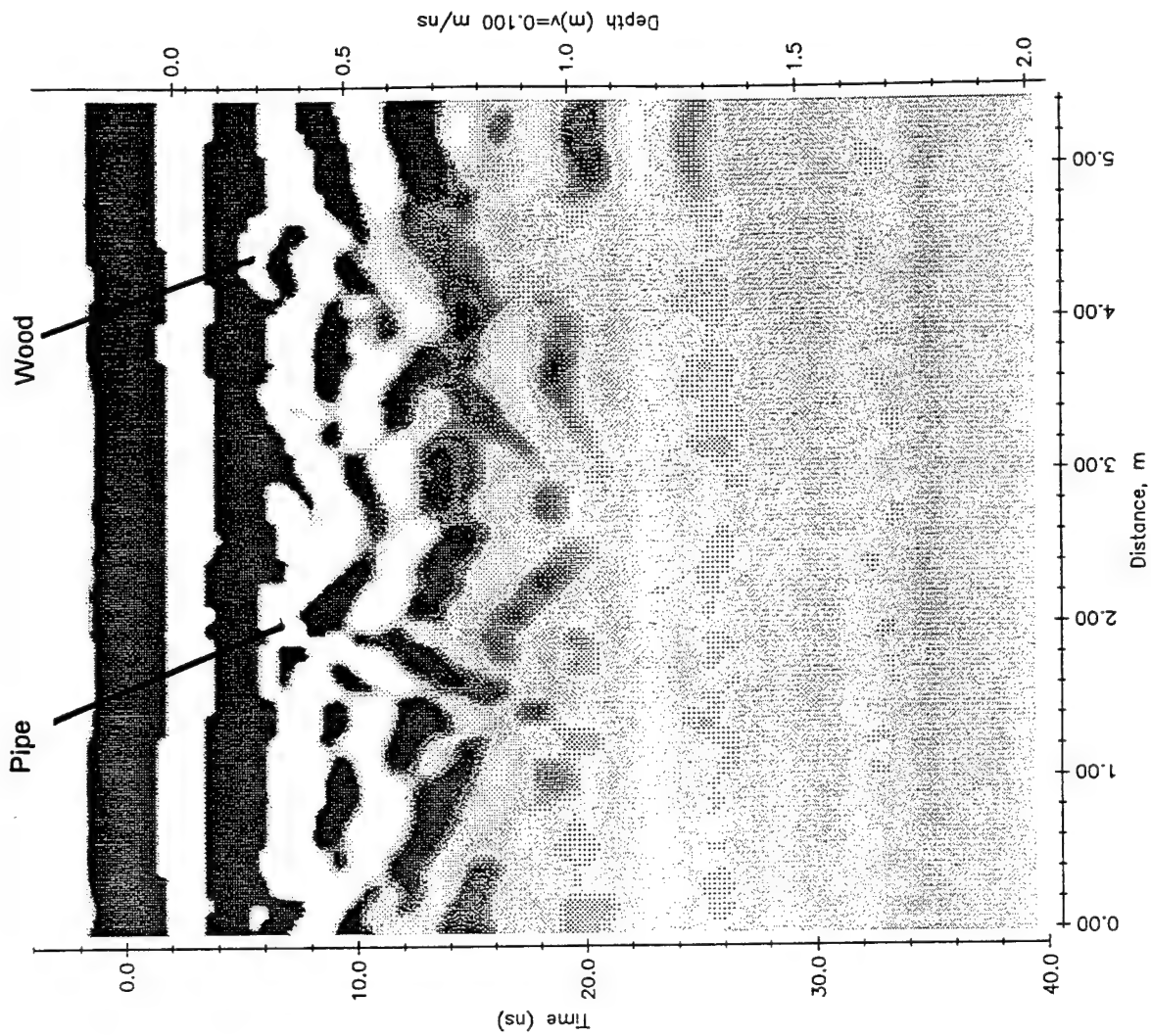
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pulseEKKO  HEADER PARAMETERS
FILE      = s:\COASTIG~1\205LPO~1\CG250CP.3
JOB#      =
TITLE     = Alabama Shipyard, Bulk Handling Area
DATE      = 09/20/20
NUMBER OF TRACES = 100
NUMBER OF PLS/TRC = 111
TIMEZERO AT POINT = 11
TOTAL TIME WINDOW = 44
STARTING POSITION = 0.000
FINAL POSITION = 5.400
STEP SIZE USED = 0.050
POSITION UNITS = m
NOMINAL FREQUENCY = 250.00
ANTENNA SEPARATION = 0.305
PULSER VOLTAGE = 100
NUMBER OF STACKS = 16
SURVEY MODE = Reflection

PROCESSING SELECTED
FILTERS:  TRACE STACKING: 2
          POINT STACKING: 2
          TRACE DIFFERENCING: N
          CORRECTION: DEWOW
SELECTION TIME: -4 to 40
GAINS:     POSITIONS: 0.000 to 5.400
          GAIN TYPE: CONSTANT
          MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS
TRACE SPACING AND WIDTH: 0.0600 and 0.2500
TRACE BOTTOM AND TOP: 1.0000 and 9.0000
MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0

```



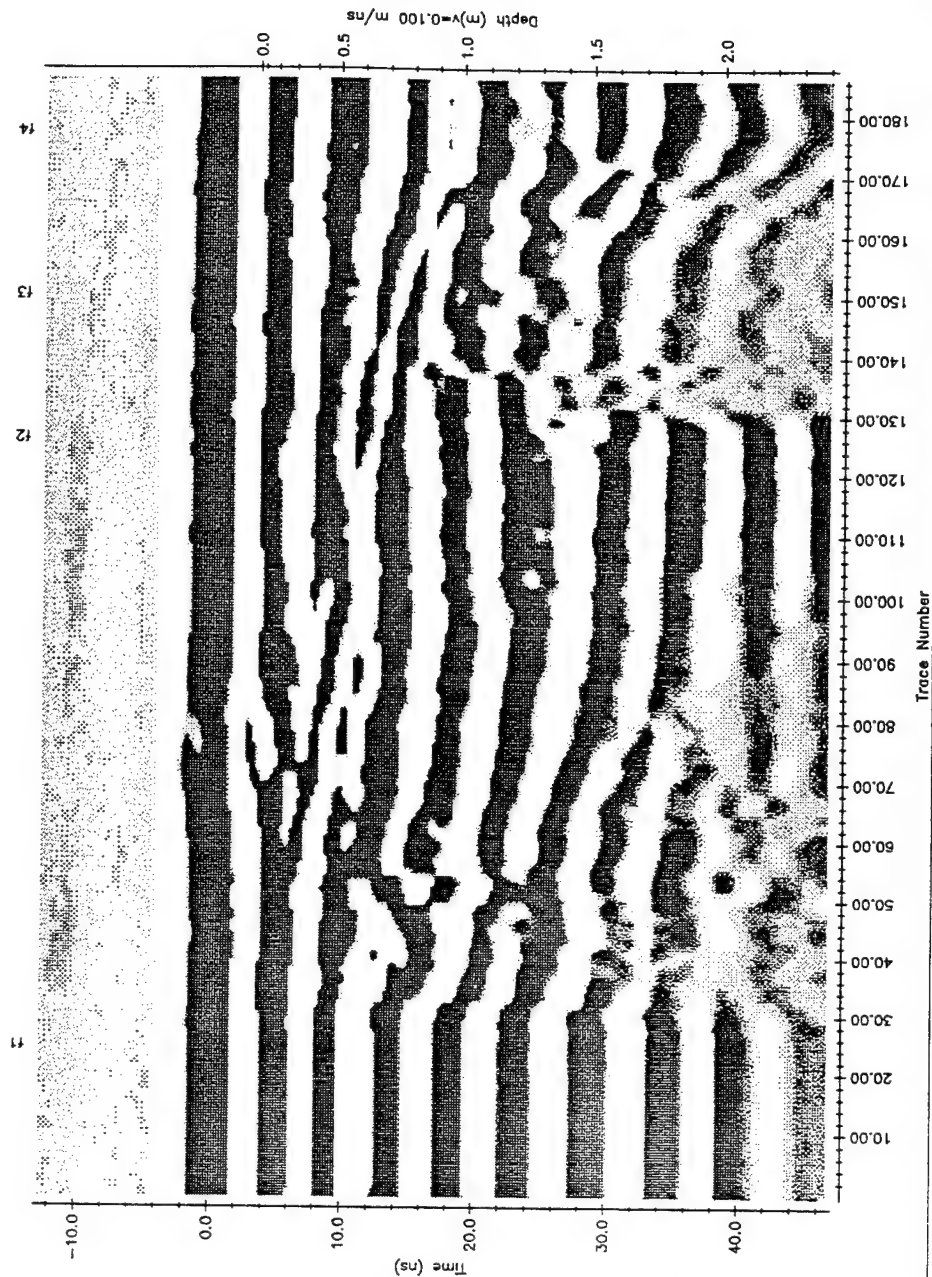
**Appendix E**  
**Crystal Gypsum**  
**GPR Records – Buried Contraband**  
**Simulant Test**

---

pulseECHO HEADER PARAMETERS  
 FILE = S:\COASTG~1\21SEP90~1\CG225GS  
 JOB# =  
 TITLE = Alabarca Ship-ord, Bulk Handling Area  
 DATE = 21/09/90  
 TIME = 12:55:47  
 NUMBER OF TRACES = 187  
 NUMBER OF PTS/TRC = 200  
 TIMEZERO AT POINT = 44  
 TOTAL TIME WINDOW = 60  
 STARTING POSITION = 0.000  
 FINAL POSITION = 156.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 225.00  
 NOMINAL SEPARATION = 0.500  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - COR: 981119 RX: 981120  
 TX: 981121 ANT: 971195/96

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -13 to 47  
 POSITIONS: 0.000 to 186.000  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

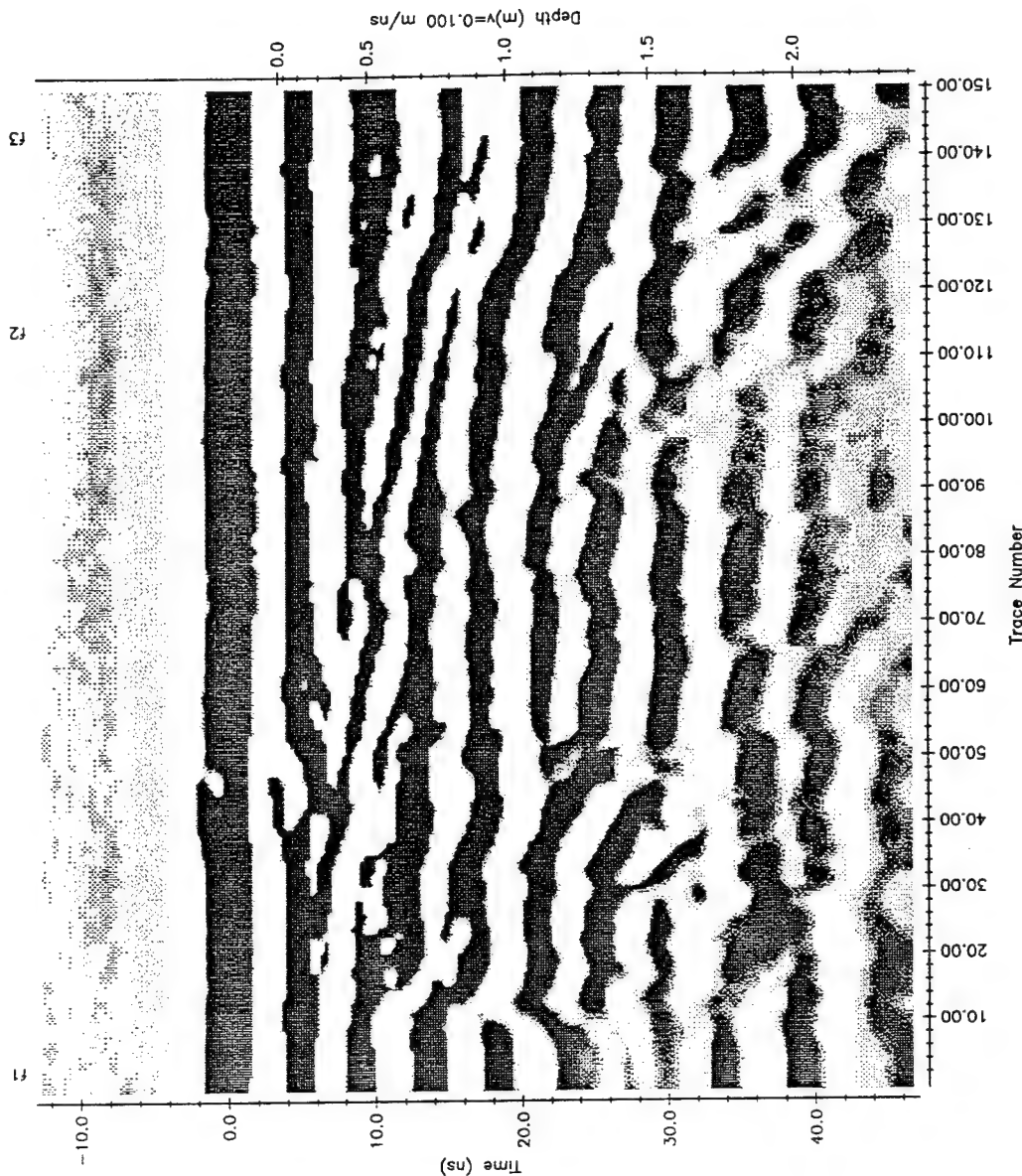
PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.0500 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:Grey Type:LA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS  
 FILE = S:\COASTG~\21SEPO~\VCG225GS2  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Crystal Gypsum Pile, 225 kHz, Sugar - North Edge of Pile  
 DATE = 21/09/10  
 NUMBER OF TRACES = 151  
 TIMEZERO AT POINT = 44  
 TOTAL TIME WINDOW = 60  
 STARTING POSITION = 0.000  
 FINAL POSITION = 150.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 225.00  
 ANTEHNA SEPARATION = 0.500  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - COH: 981119 RX: 981120  
 TX: 981121 ANT: 971195/96

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 SELECTION TIME: -13 to 47  
 POSITIONS: 0.000 to 150.000  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.0600 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: None:GREY Type:EA Expansion:0.500 Contour:0



FILE = s:\COASTG~1\21SEPO~1\CG225053  
 JOB# = Albanna Shipyard, Bulk Handling Area  
 TITLE = Crystal Gypsum File, 225 MHz, Sugar -- Profile Over Sugar  
 DATE = 21/05/10  
 NUMBER OF TRACES = 179  
 NUMBER OF FTS/THC = 250  
 FREQUENCY AT POINT = 44  
 CHANNEL BANDWIDTH = 60  
 STARTING POSITION = 0.000  
 FINAL POSITION = 178.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 225.000  
 ANTENNA SEPARATION = 0.500  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 -- COR: 981119 RX: 981120  
 TX: 981121 ANT: 971195/96

#### PROCESSING SELECTED FILTERS:

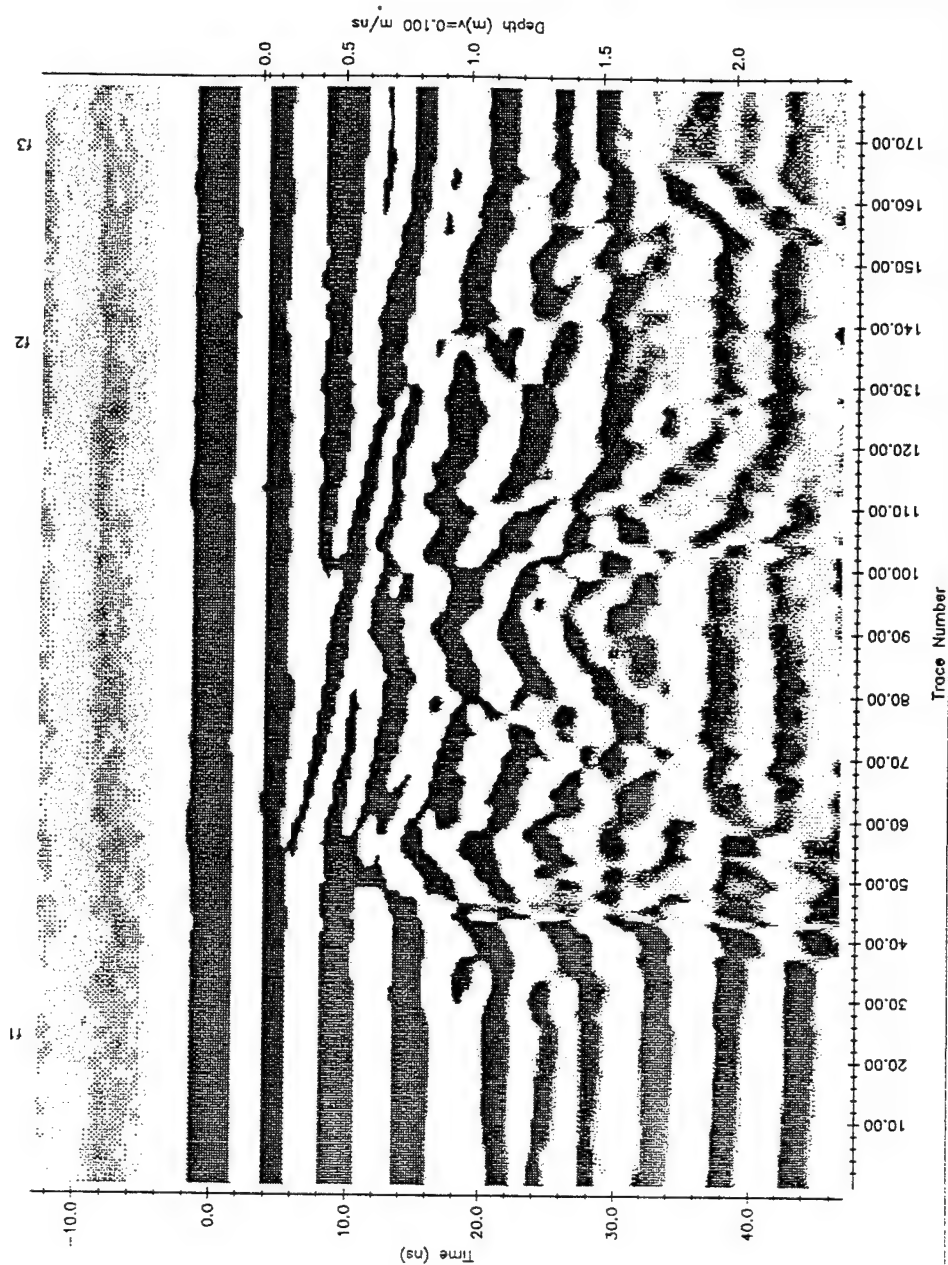
TRACE STACKING: 2  
 POINT DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -13 to 47

#### SELECTION

POSITIONS: 0.000 to 178.000  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

#### PLOT LAYOUT PARAMETERS

TRACE SPACING AND WIDTH: 0.0600 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:FA Expansion:0.500 Contour:0

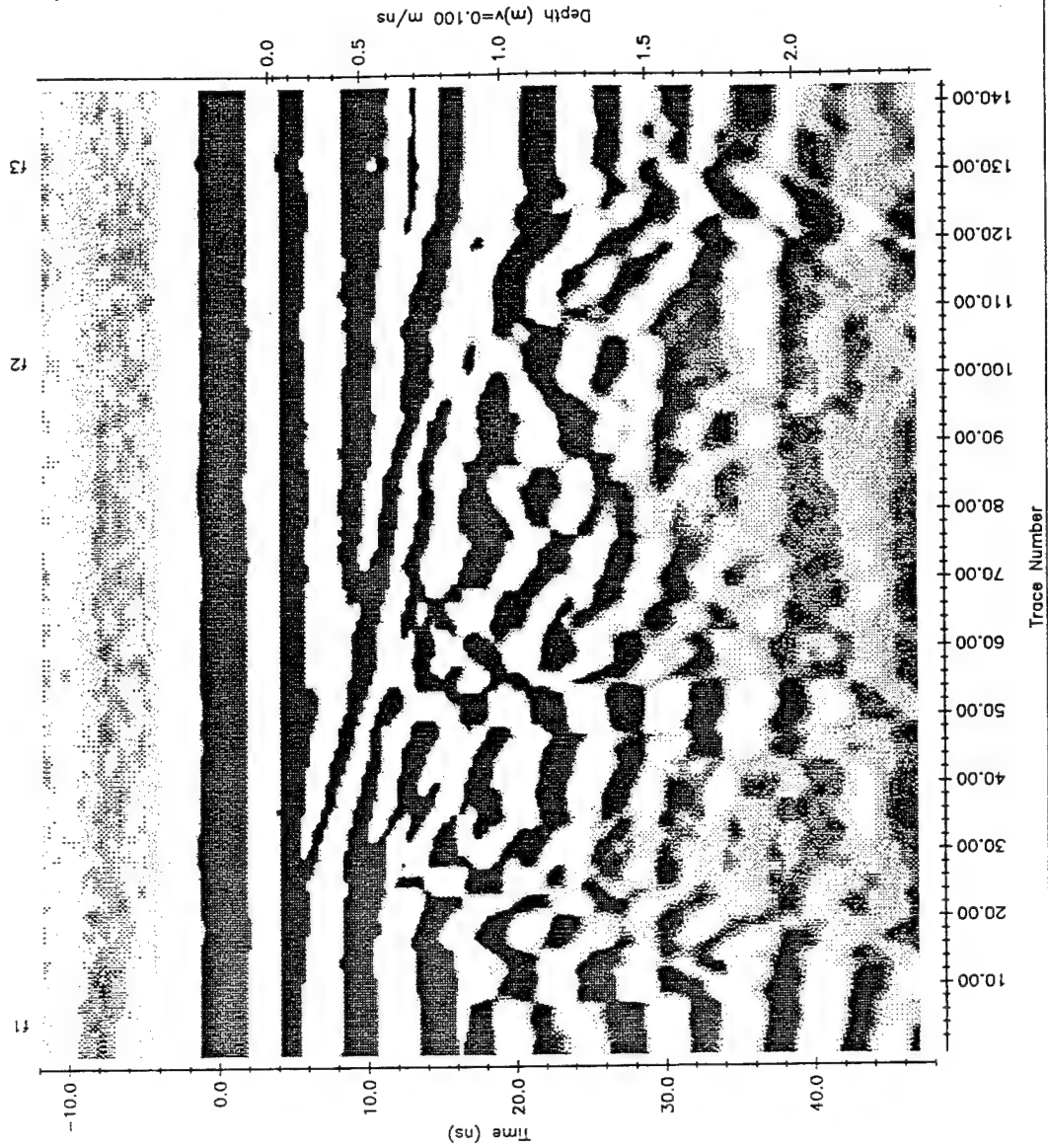




pulseEKKO HEADER PARAMETERS  
 FILE = S:\CONSIG\N215100~NCC225054  
 .hhp  
 HILL = Gyalal Gypsam File, 2.25 MHz, Augur  
 Profile Over Augur  
 DATE = 21/09/10  
 NUMBER OF TRACES = 143  
 NUMBER OF PTS/TRC = 200  
 TIMEZERO AT POINT = 43  
 TOTAL TIME WINDOW = 60  
 STARTING POSITION = 0.000  
 FINAL POSITION = 142.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 225.00  
 ANTENNA SEPARATION = 0.500  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971195/96

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 SELECTION  
 TIME: -12 to 48  
 POSITIONS: 0.000 to 142.000  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

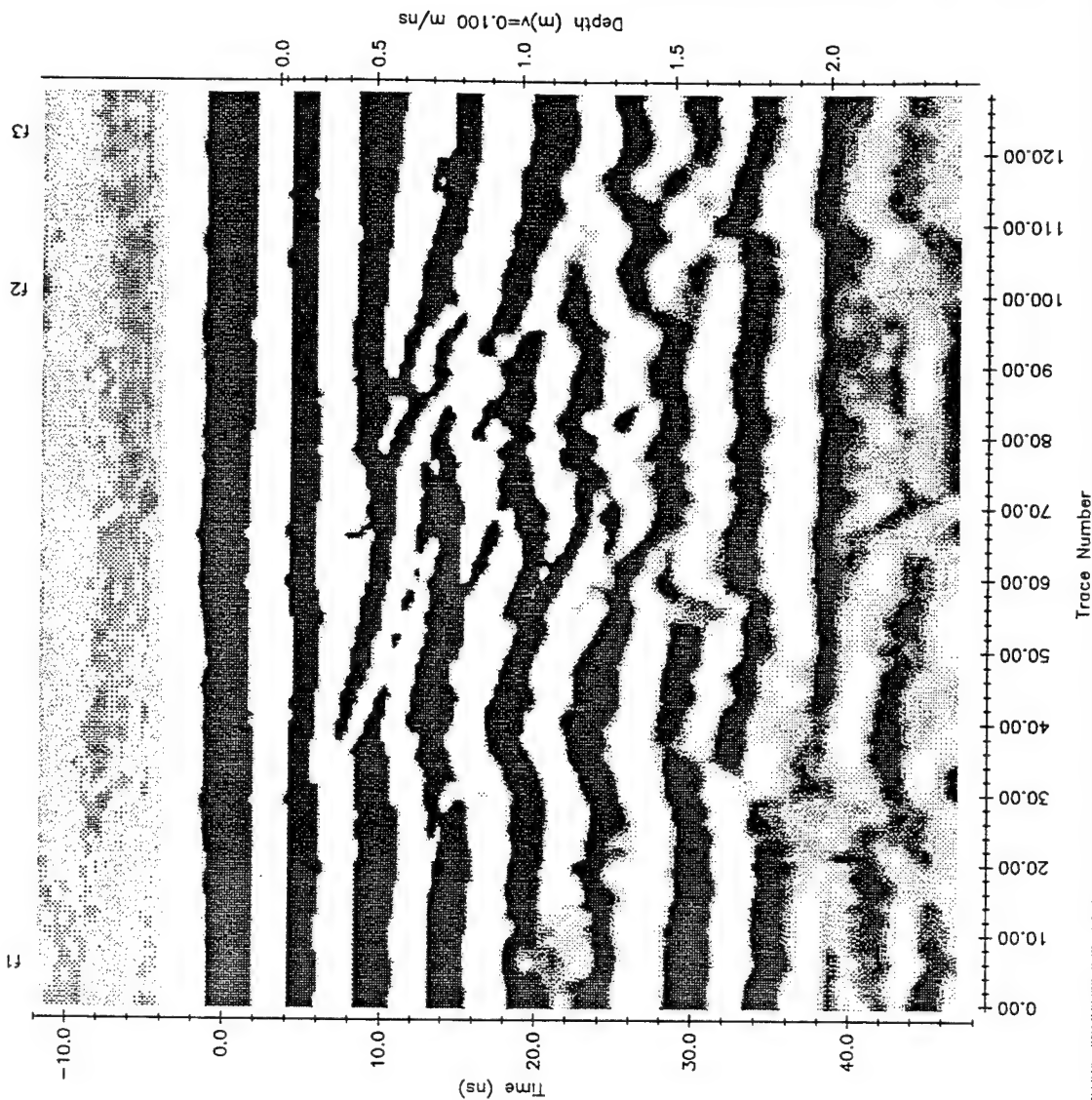
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 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseKHO HEADER PARAMETERS  
 FILE = s:\COASTG~1\21SEP0~1\CG225GS5  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Crystal Gypsum Pile, 225 MHz, Sugar - South Edge of Pile  
 DATE = 21/09/10  
 NUMBER OF TRACES = 129  
 NUMBER OF PTS/TRC = 200  
 TIMEZERO AT POINT = 43  
 TOTAL TIME WINDOW = 60  
 STARTING POSITION = 0.000  
 FINAL POSITION = 128.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 225.00  
 ANTENNA SEPARATION = 0.500  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971195/96

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 SELECTION TIME: -12 to 48  
 POSITIONS: 0.000 to 128.000  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

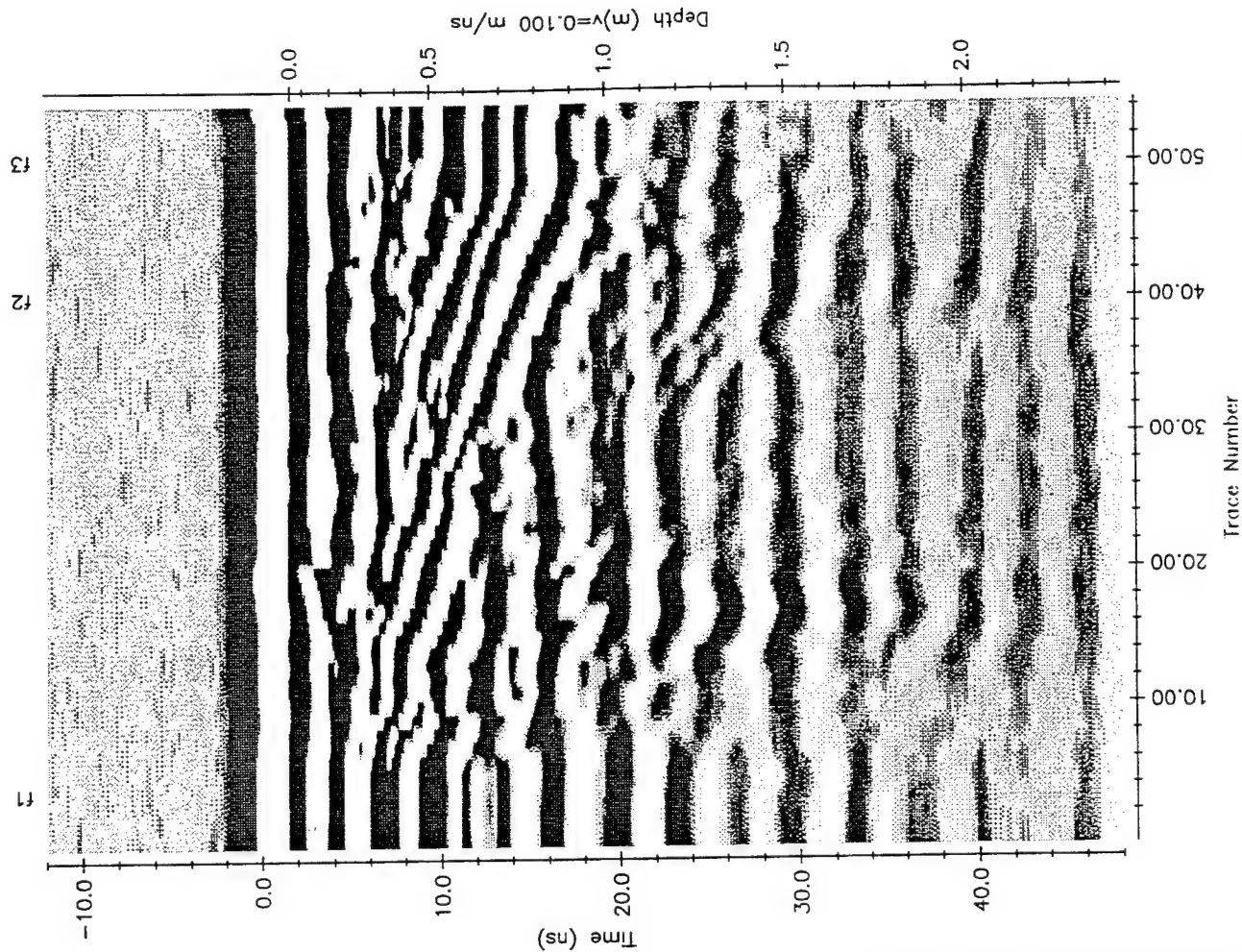
PLOT LAYOUT PARAMETERS  
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 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\21SEP0~1\CG450GS1  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Crystal Gypsum Pile, 450 MHz, Sugar - North Edge of Sugar  
 DATE = 21/09/10  
 NUMBER OF TRACES = 55  
 NUMBER OF PTS/TRC = 600  
 TIMEZERO AT POINT = 120  
 TOTAL TIME WINDOW = 60  
 STARTING POSITION = 0.000  
 FINAL POSITION = 54.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 450.00  
 ANTENNA SEPARATION = 0.250  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971181/82

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -12 to 48  
 SELECTION POSITIONS: 0.000 to 54.000  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.1000 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name: GREY Type: LA Expansion: 0.500 Contour: 0



```

pulseEKKO HEADER PARAMETERS
FILE = s:\COASTG~1\21SEP0~1\CG450CS2
JOB# =
TITLE = Alabama Shipyard, Bulk Handling Area
DATE = 21/09/10
NUMBER OF TRACES = 60
NUMBER OF PTS/TRC = 600
TIMEZERO AT POINT = 119
TOTAL TIME WINDOW = 60
STARTING POSITION = 0.000
FINAL POSITION = 59.000
STEP SIZE USED = 1.000
POSITION UNITS = metres
NOMINAL FREQUENCY = 450.00
ANTENNA SEPARATION = 0.250
PULSER VOLTAGE = 200
NUMBER OF STACKS = 16
SURVEY MODE = Reflection
COLLECTED BY PE1000 -- CON: 981119 RX: 981120
TX: 981121 ANT: 971181/82

```

```

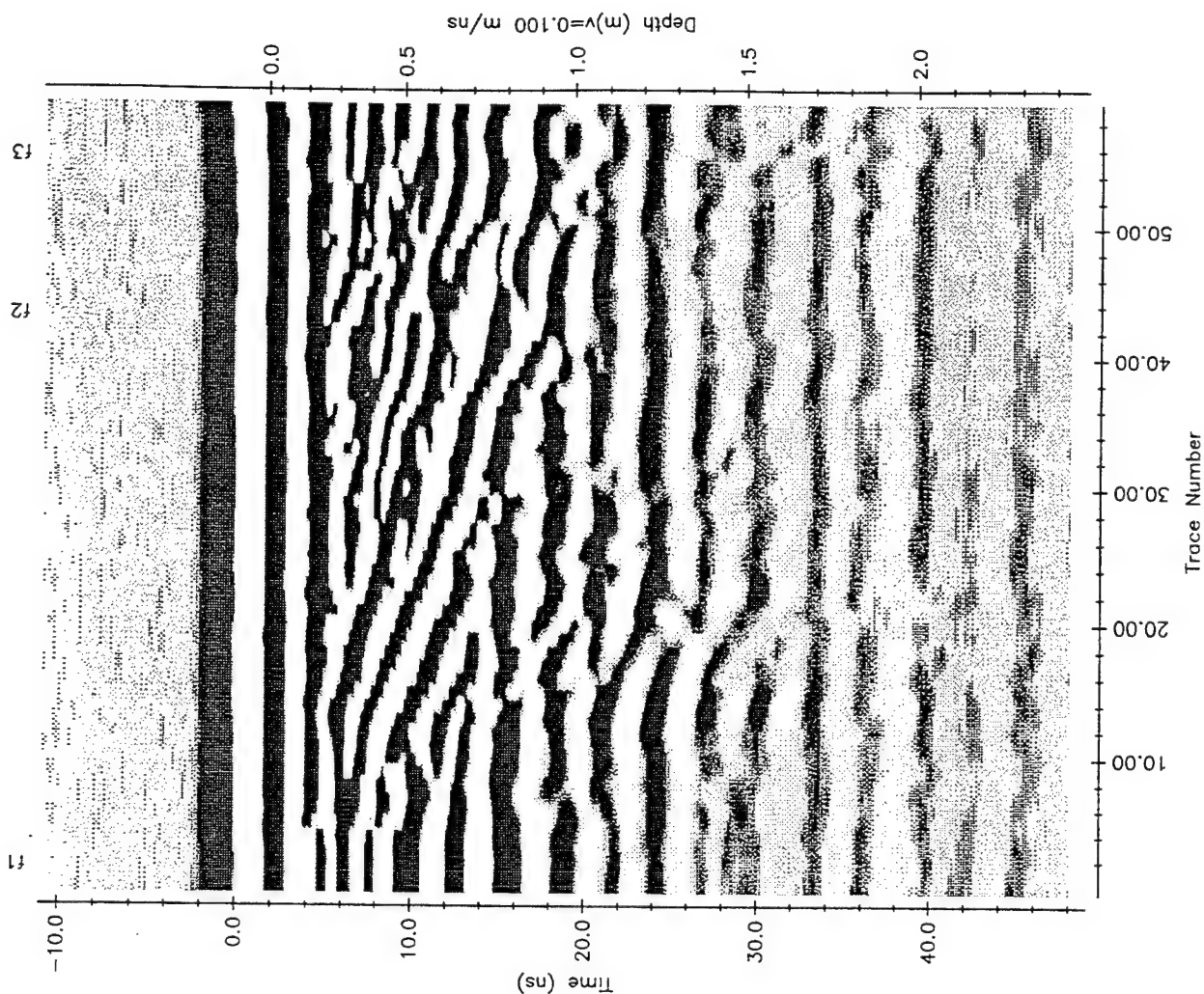
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FILTERS:
TRACE STACKING: 2
POINT STACKING: 2
TRACE DIFFERENCING: N
CORRECTION: DEWOW
TIME: -11 to 49
SELECTION
POSITIONS: 0.000 to 59.000
GAINS:
GAIN TYPE: CONSTANT
MULTIPLIER: 100.000

```

```

PLOT LAYOUT PARAMETERS
TRACE SPACING AND WIDTH: 0.1000 and 0.2500
TRACE BOTTOM AND TOP: 1.0000 and 9.0000
MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0

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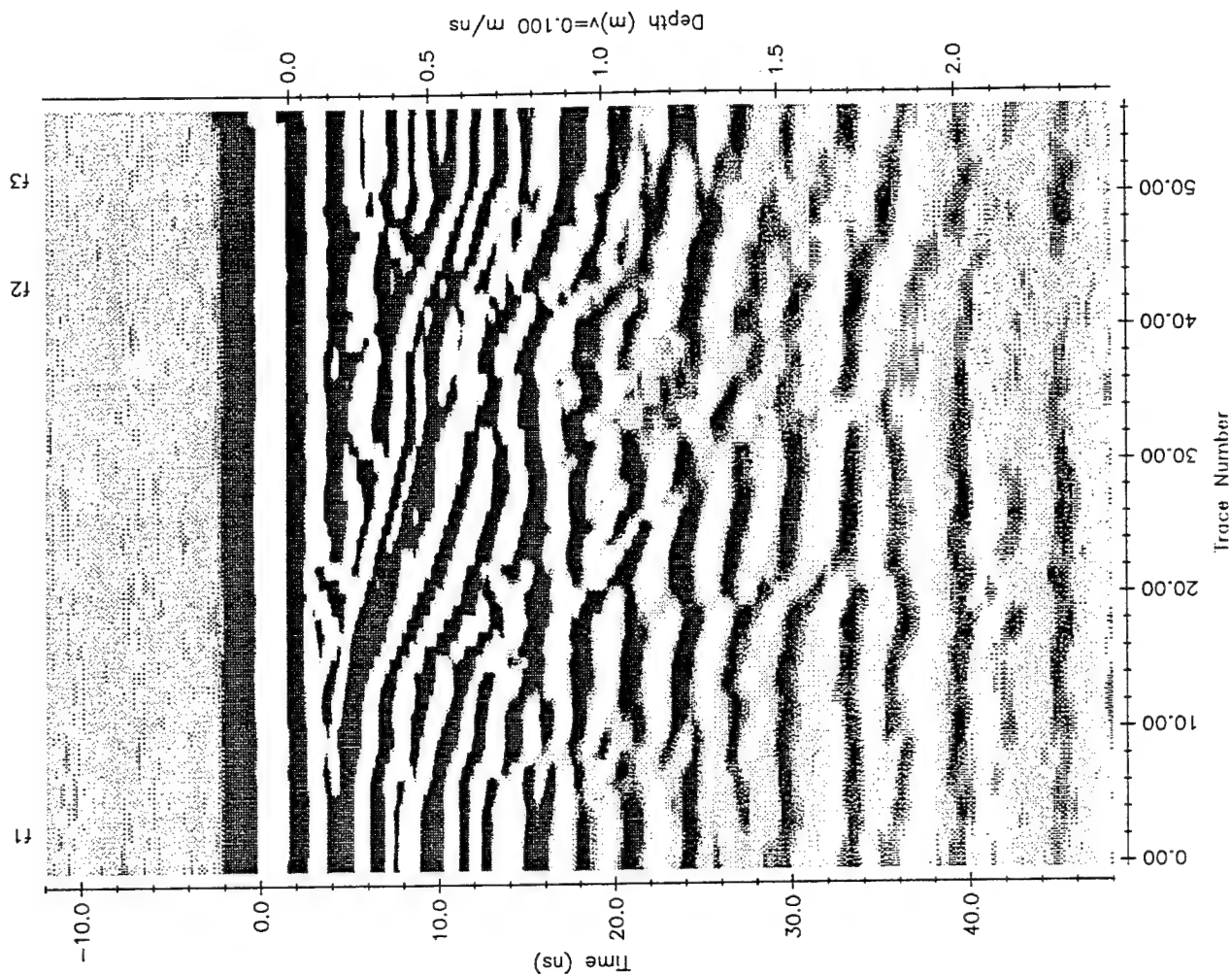
pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\21SEPO~1\CG450GS3  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Crystal Gypsum Pile, 450 MHz, Sugar - South Edge of Pile  
 DATE = 21/09/10  
 NUMBER OF TRACES = 57  
 NUMBER OF PTS/TRC = 600  
 TIMEZERO AT POINT = 120  
 TOTAL TIME WINDOW = 60  
 STARTING POSITION = 0.000  
 FINAL POSITION = 56.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 450.00  
 ANTENNA SEPARATION = 0.250  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - COR: 981119 RX: 981120  
 TX: 981121 ANT: 971191, 37

#### PROCESSING SELECTED

FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -12 to 48  
 POSITIONS: 0.000 to 56.000  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

#### PLOT LAYOUT PARAMETERS

TRACE SPACING AND WIDTH: 0.1000 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0

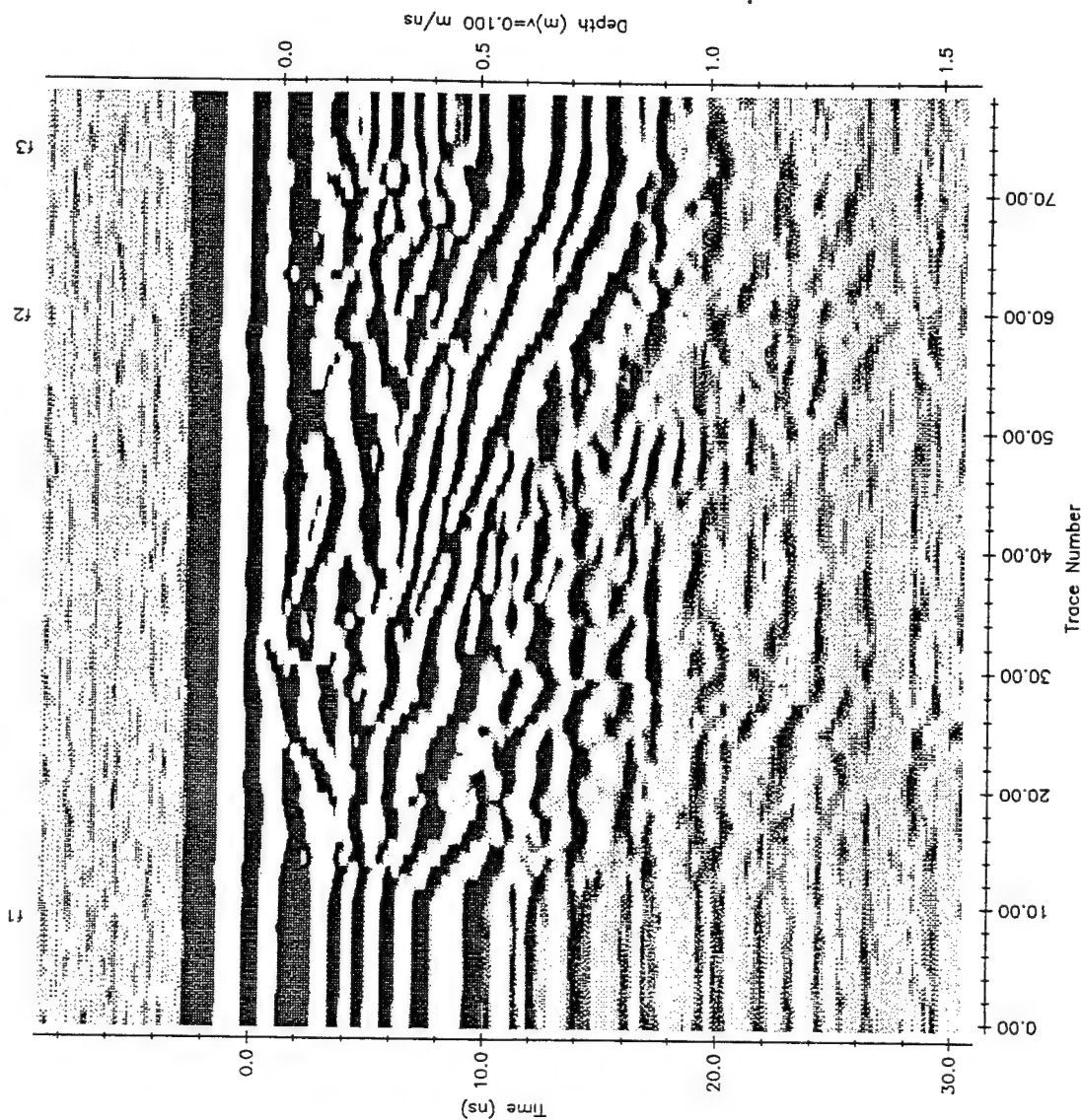




pulseEKKO HEADER PARAMETERS  
 FILE = S:\COASTG~1\N7151P0~1\CC000G51  
 TITLE = Abdullahi, Bulk Handling Area - North Edge of Pile  
 DATE = 21/09/10  
 NUMBER OF TRACES = 79  
 NUMBER OF PTS/TRC = 400  
 TIMEZERO AT POINT = 95  
 TOTAL TIME WINDOW = 40  
 STARTING POSITION = 0.000  
 FINAL POSITION = 78.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 900.00  
 ANTENNA SEPARATION = 0.170  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 4  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971258/59

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -9 to 31  
 POSITIONS: 0.000 to 78.000  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.1000 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0

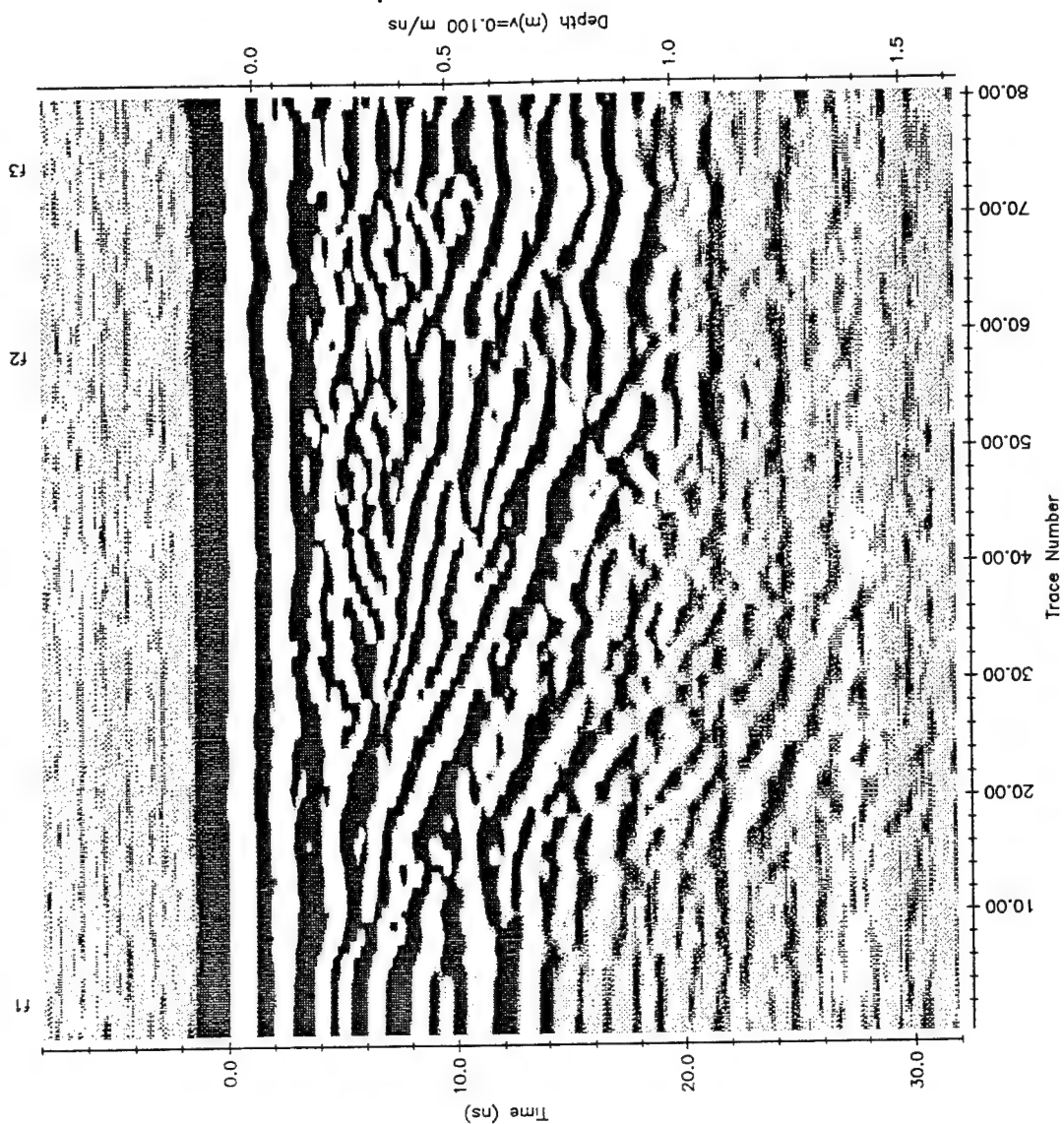




pulseKKO HEADER PARAMETERS:  
 FILE = 5.ACOMA1C~1A:151 PD~IN C900G1.2  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Crystal Gypsum Pile, 900 MHz, Sugar - Profile Over Sugar  
 DATE = 21/09/10  
 NUMBER OF TRACES = 81  
 NUMBER OF PTS/TRC = 400  
 TIMEZERO AT POINT = 81  
 TOTAL TIME WINDOW = 40  
 STARTING POSITION = 0.000  
 FINAL POSITION = 80.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 900.00  
 ANTENNA SEPARATION = 0.1/0  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 4  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CORF 981119 RX: 981120  
 TX: 981121 ANT: 971258/59

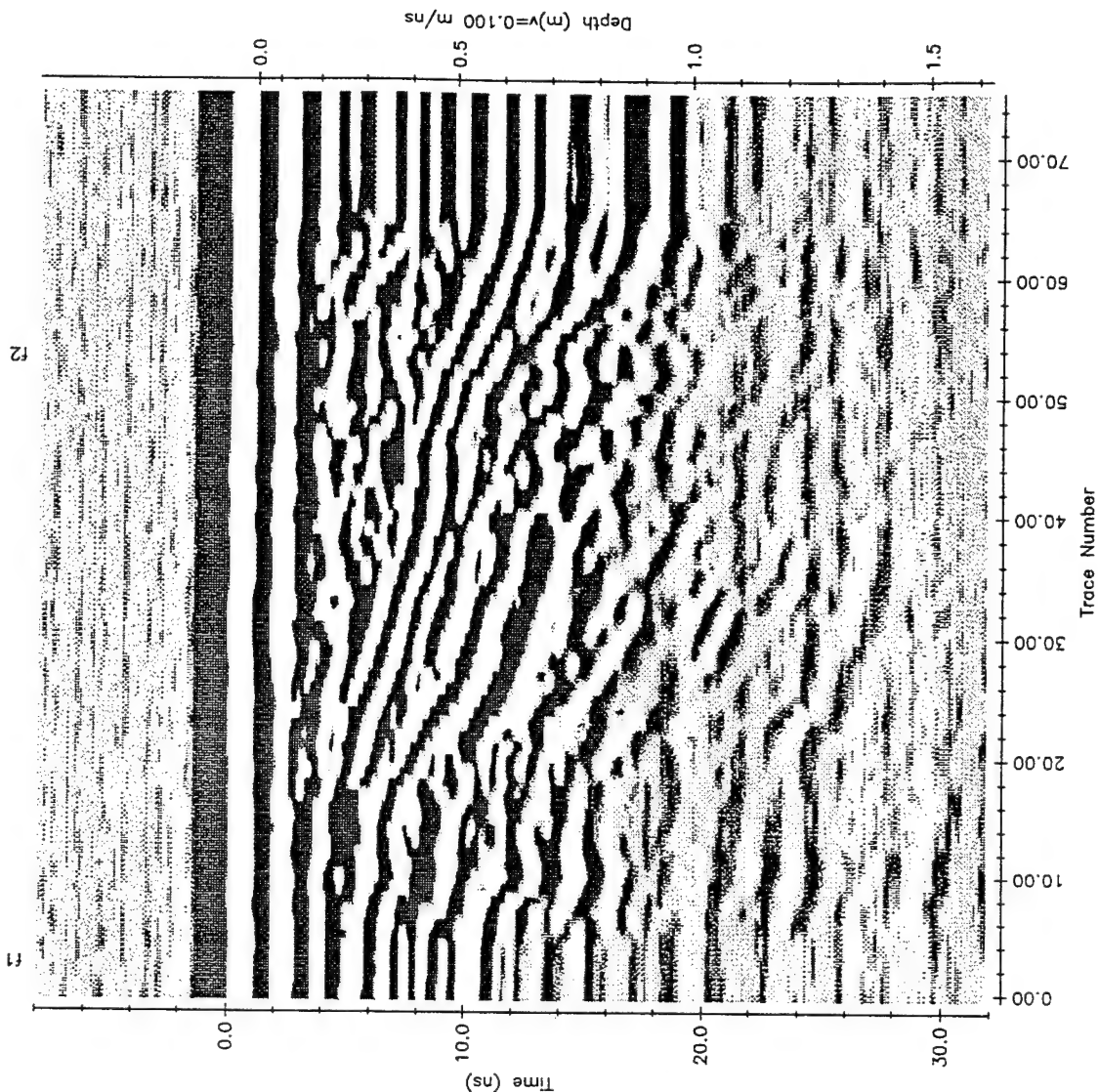
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 FILTERS: TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 SELECTION TIME: -8 to 32  
 POSITIONS: 0.000 to 80.000  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.1000 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\21SEP0~1\CG900G53  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Crystal Gypsum Pile, 900 MHz, Sugar - South Edge of Pile  
 DATE = 21/09/10  
 NUMBER OF TRACES = 76  
 NUMBER OF PTS/TRC = 400  
 TIMEZERO AT POINT = 81  
 TOTAL TIME WINDOW = 40  
 STARTING POSITION = 0.000  
 FINAL POSITION = 75.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 900.00  
 ANTENNA SEPARATION = 0.170  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 4  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 -- CON: 981119 RX: 981120  
 TX: 981121 ANT: 971258/59

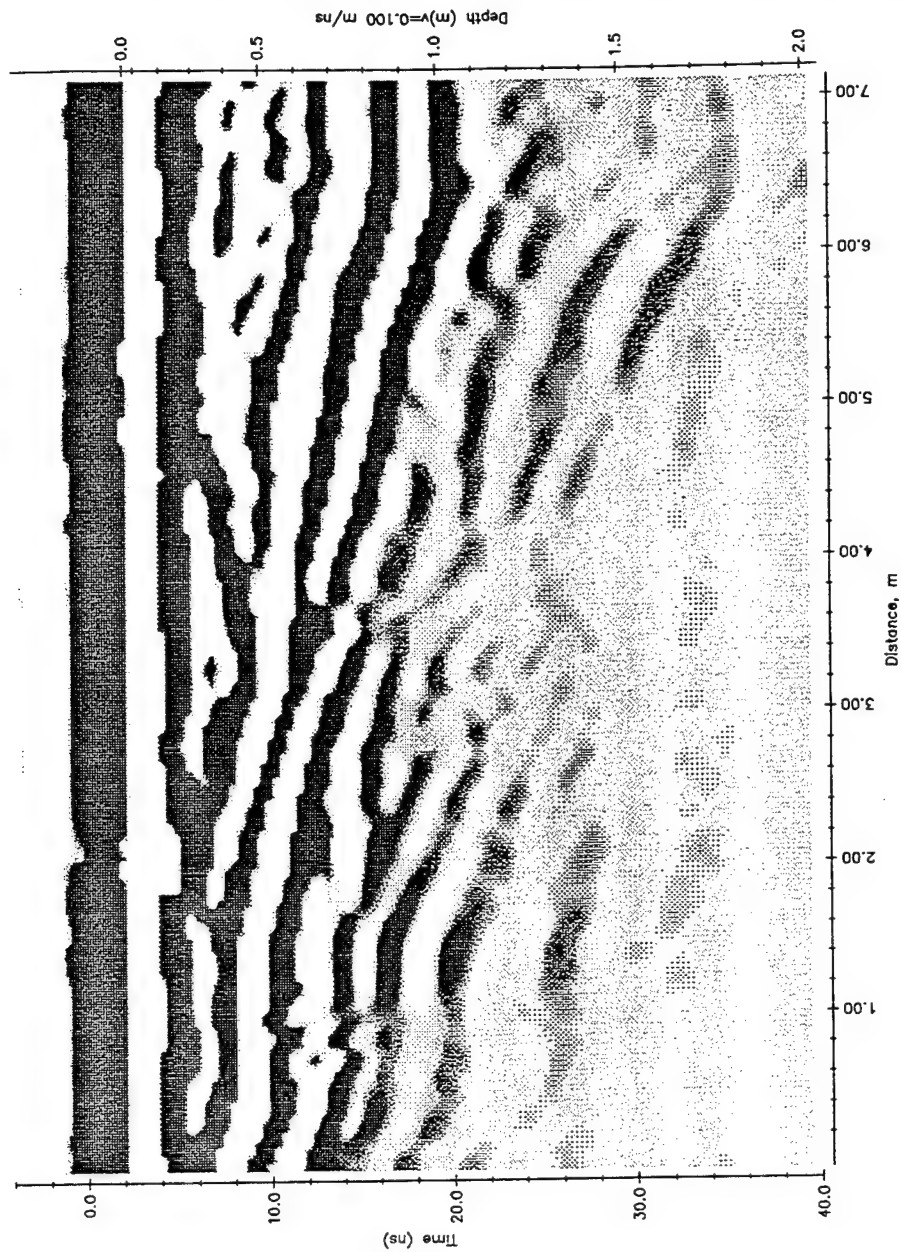
PROCESSING SELECTED  
 FILTERS: TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -8 to 32  
 SELECTION POSITIONS: 0.000 to 75.000  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000  
 PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.1000 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



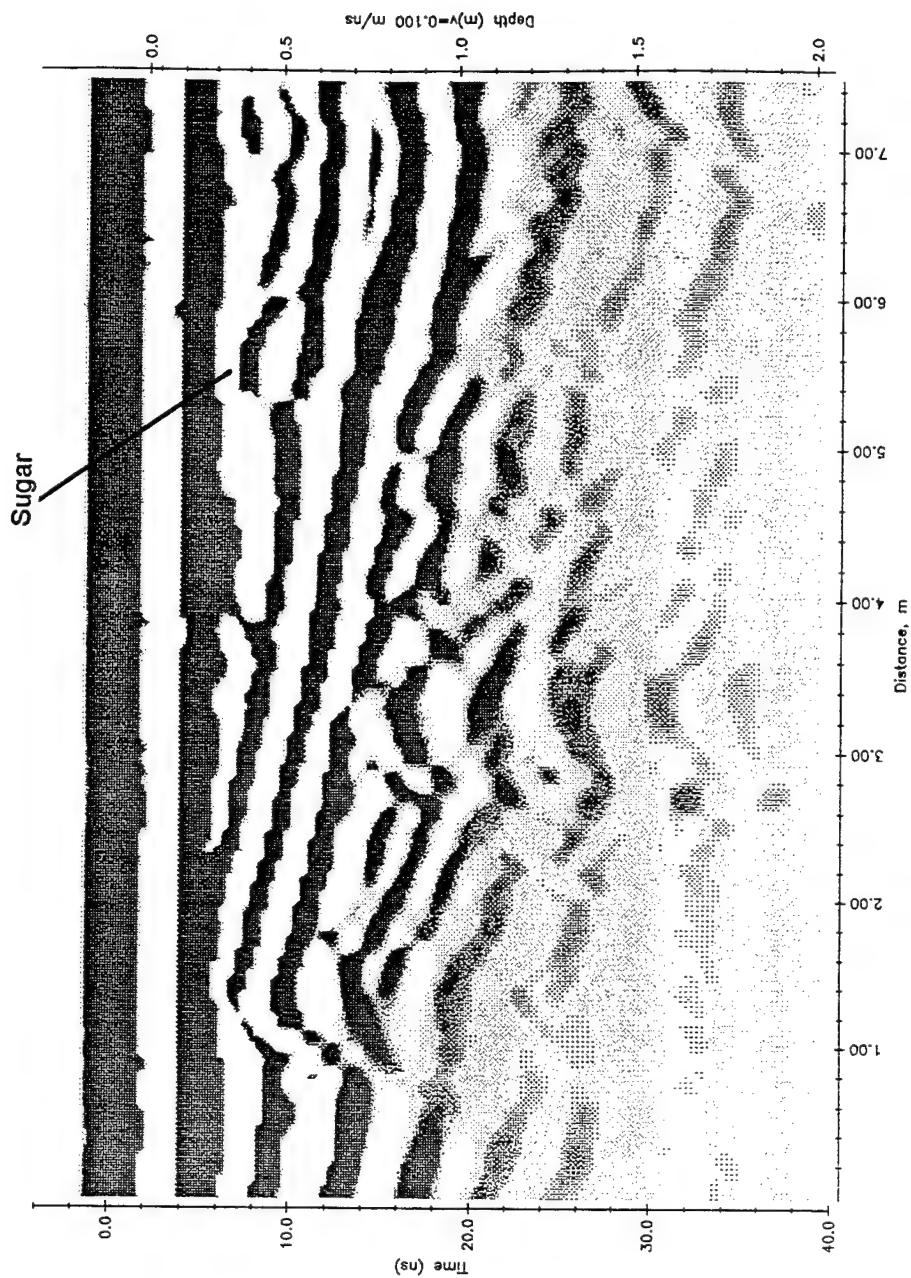
pulsed KKO TILAUER PARAML III's  
 FILE = s:\COASTG~\21SEP0~\NCG250G50  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Crystal Gypsum Pile, 250 MHz, Sugar -- North Edge of Pile  
 DATE = 09/11/00  
 NUMBER OF TRACES = 143  
 NUMBER OF PTS/RC = 111  
 TIME ZERO AT POINT = 11  
 TOTAL TIME WINDOW = 44  
 STARTING POSITION = 0.000  
 FINAL POSITION = 7.100  
 STEP SIZE USED = 0.050  
 POSITION UNITS = m  
 NOMINAL FREQUENCY = 250.00  
 ANTENNA SEPARATION = 0.305  
 PULSER VOLTAGE = 100  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection

PROCESSING SELECTED  
 FILTERS: TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 SELECTION TIME TO 7.100  
 POSITIONS: 0.000 to 7.100  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

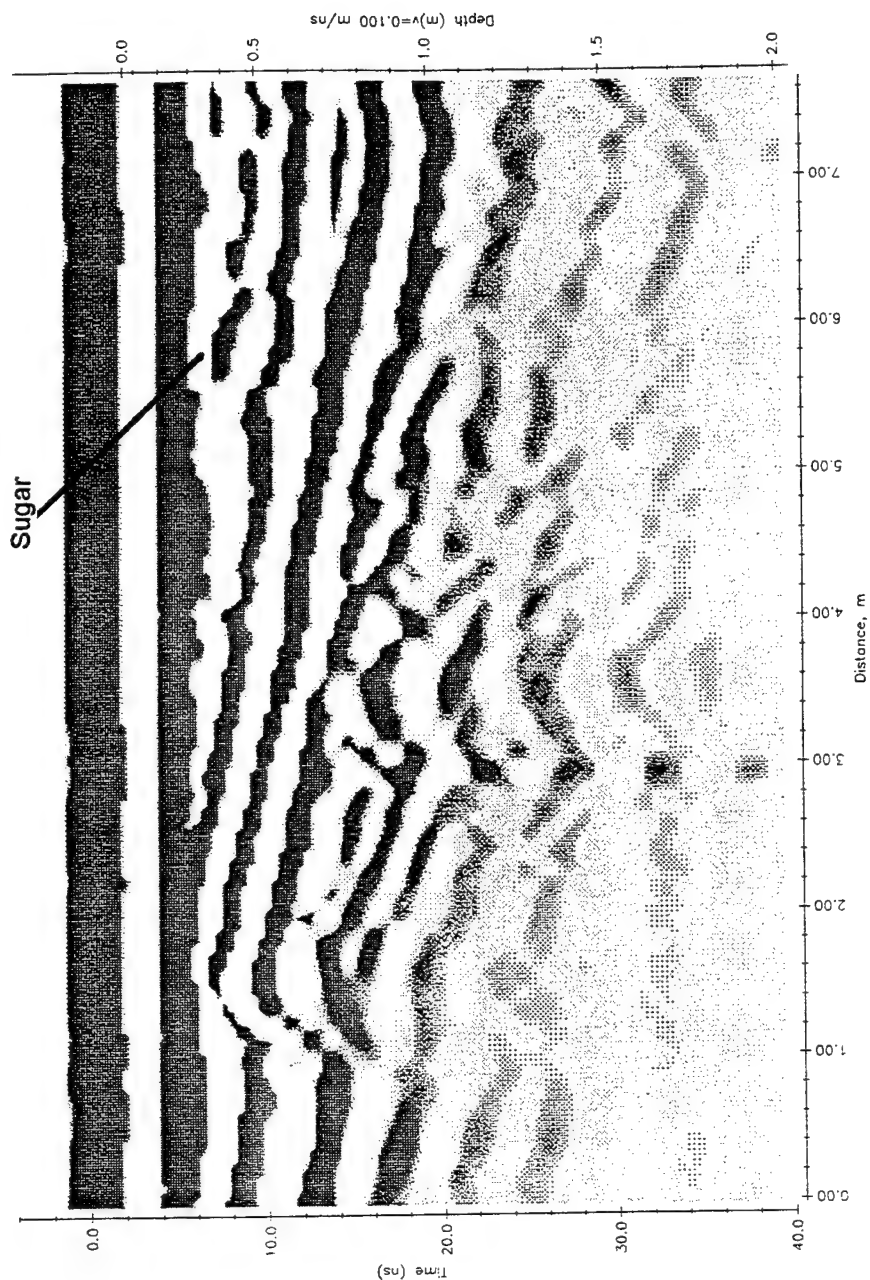
PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.0750 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: None-GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\21SEPO~1\CG250G51  
 JOB# =  
 TITLE = Alabama Shipyard, Bulk Handling Area  
 TITLE = C:\msi\cypsum File, 250 MHz, Sugar - Profile Over Sugar  
 DATE = 09/21/2008  
 NUMBER OF TRACES = 150  
 NUMBER OF PTS/TRC = 111  
 TIMEZERO AT POINT = 11  
 TOTAL TIME WINDOW = 44  
 STARTING POSITION = 0.000  
 FINAL POSITION = 7.450  
 STEP SIZE USED = 0.050  
 POSITION UNITS = m  
 NOMINAL FREQUENCY = 250.00  
 ANTENNA SEPARATION = 0.305  
 PULSER VOLTAGE = 100  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
  
 PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT DIFFERENCING: N  
 CORRECTION: DEWOW  
 SELECTION  
 TIME: -4 to 40  
 POSITIONS: 0.000 to 7.450  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000  
  
 PLOT LAYOUT PARAMETERS  
 TRACE SPACING: 0.0750 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.0000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name: GREY Type: EA Expansion: 0.500 Contour: 0

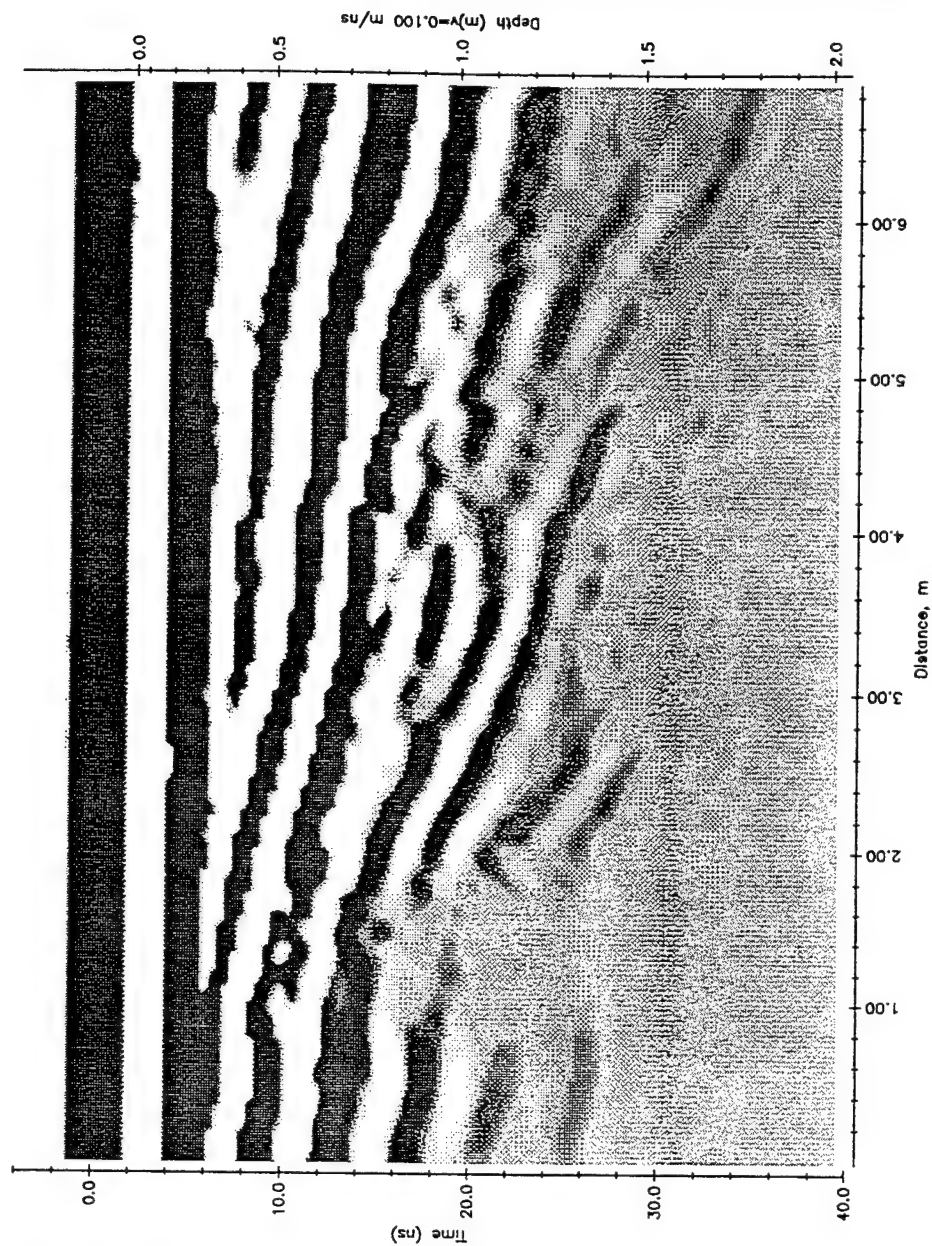


pulseEKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\21SEP70~\CG250GS2  
 JOB# =  
 TITLE = Alaboma Shipyard, Bulk Handling Area  
 DATE = 09/21/20  
 TIME = 09:21:20  
 NUMBER OF TRACES = 154  
 NUMBER OF PTS/TRC = 111  
 TIMEZERO AT POINT = 11  
 TOTAL TIME WINDOW = 44  
 STARTING POSITION = 0.000  
 FINAL POSITION = 7.650  
 STEP SIZE USED = 0.050  
 POSITION UNITS = m  
 NOMINAL FREQUENCY = 250.00  
 ANTENNA SEPARATION = 13005  
 PULSE VOLTAGE = 100  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: H  
 CORRECTION: DEWOW  
 SELECTION  
 TIME: -4 to 40  
 POSITIONS: 0.000 to 7.650  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000  
 PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.0750 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE LENGTH: 10.000  
 PAPER SIZE: 10.000  
 PRINTER NAME: LAS300  
 SCALE BAR: None:GREY Type:EA Expansion:0.500 Contour:0





pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\21SEP0~1\CG250GS3  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Crystal Gypsum Pile, 250 MHz, Sugar -- South Edge of Pile  
 DATE = 09/21/20  
 NUMBER OF TRACES = 138  
 NUMBER OF PIS/TRC = 111  
 TIMEZERO AT POINT = 11  
 TOTAL TIME WINDOW = 44  
 STARTING POSITION = 0.000  
 FINAL POSITION = 6.850  
 STEP SIZE USED = 0.050  
 POSITION UNITS = 750.00  
 NOMINAL FREQUENCY = 250.00  
 ANTENNA SEPARATION = 1.305  
 PULSER VOLTAGE = 160  
 NUMBER OF STACKS = 18  
 SURVEY MODE = Reflection  
 PROCESSING SELECTED  
 FILTERS: TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 SELECTION TIME: -4 to 40  
 POSITIONS: 0.000 to 6.850  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000  
 PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.0750 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contaur:0

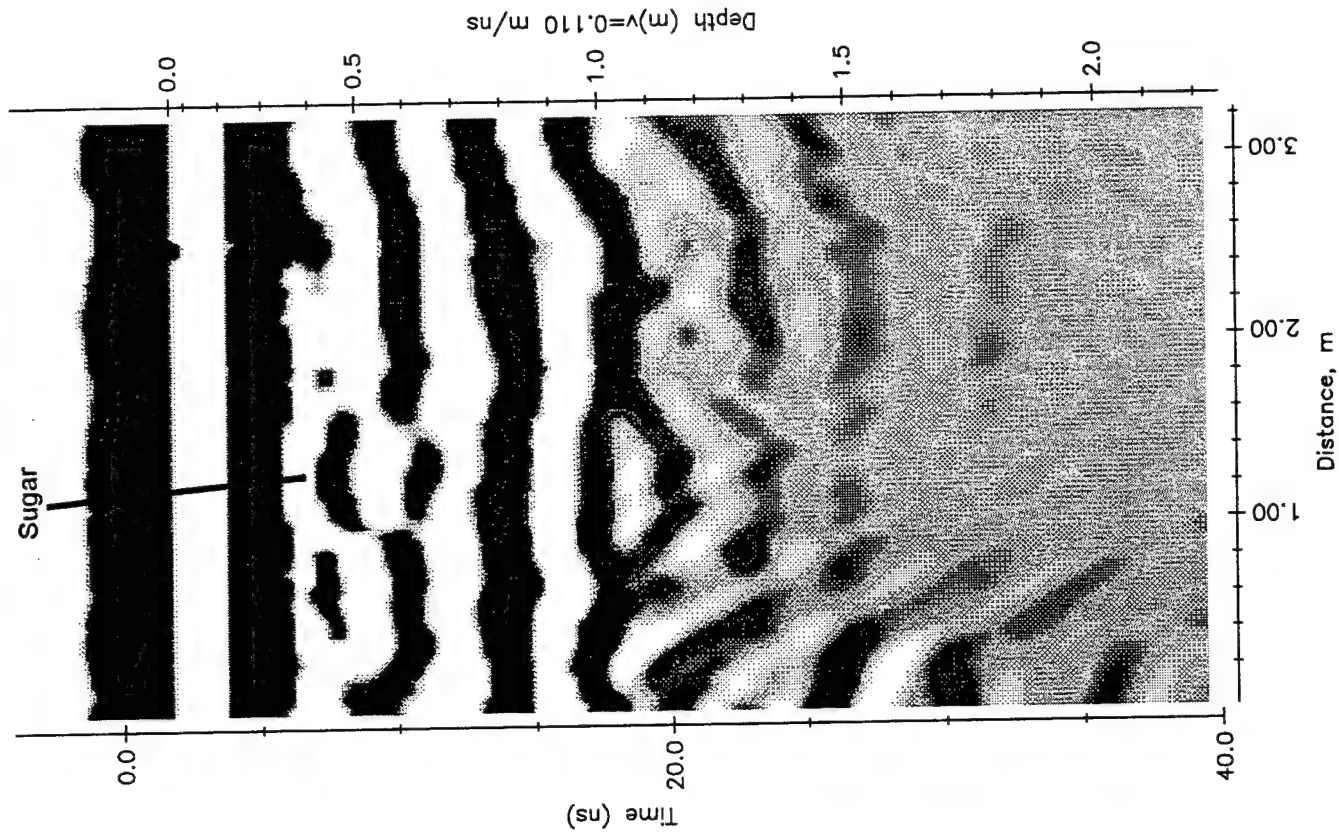




pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\21SEP0~1\CG250GS4  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Crystal Gypsum Pile, 250 MHz, Sugar - N/S Profile Over Sugar  
 DATE = 09/21/20  
 NUMBER OF TRACES = 65  
 NUMBER OF PTS/TRC = 111  
 TIMEZERO AT POINT = 11  
 TOTAL TIME WINDOW = 44  
 STARTING POSITION = 0.000  
 FINAL POSITION = 3.200  
 STEP SIZE USED = 0.050  
 POSITION UNITS = m  
 NOMINAL FREQUENCY = 250.00  
 ANTENNA SEPARATION = 0.305  
 PULSER VOLTAGE = 100  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection

PROCESSING SELECTED  
 FILTERS: TRACE STACKING: 1  
 POINT STACKING: 5  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 SELECTION TIME: -4 to 40  
 POSITIONS: 0.000 to 3.200  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.0600 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



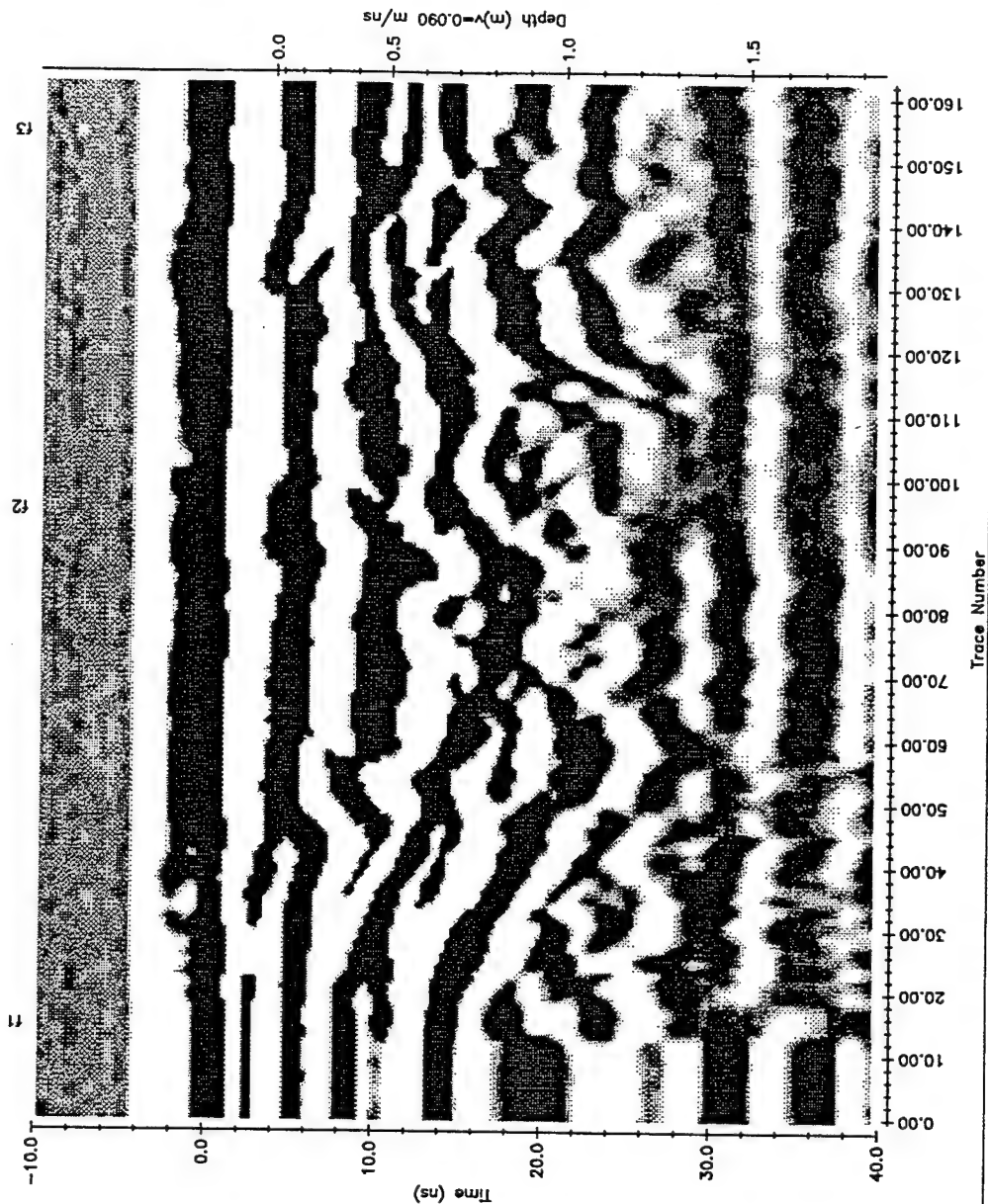
**Appendix F**  
**Powdered Gypsum**  
**GPR Records – Buried Contraband**  
**Simulant Test**

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pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\21SEP0~\CG225PS1  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Powered Gypsum Pile, 225 MHz, Sugar - West Edge of Pile  
 DATE = 21/09/10  
 NUMBER OF TRACES = 163  
 NUMBER OF PTS/TRC = 34  
 TIMEZERO AT POINT = 50  
 TOTAL TIME WINDOW = 0.000  
 STARTING POSITION = 162.000  
 FINAL POSITION = 1.000  
 STEP SIZE USED = metres  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 225.00  
 ANTENNA SEPARATION = 0.500  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 4  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971195/96

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -10 to 40  
 POSITIONS: 0.000 to 162.000  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

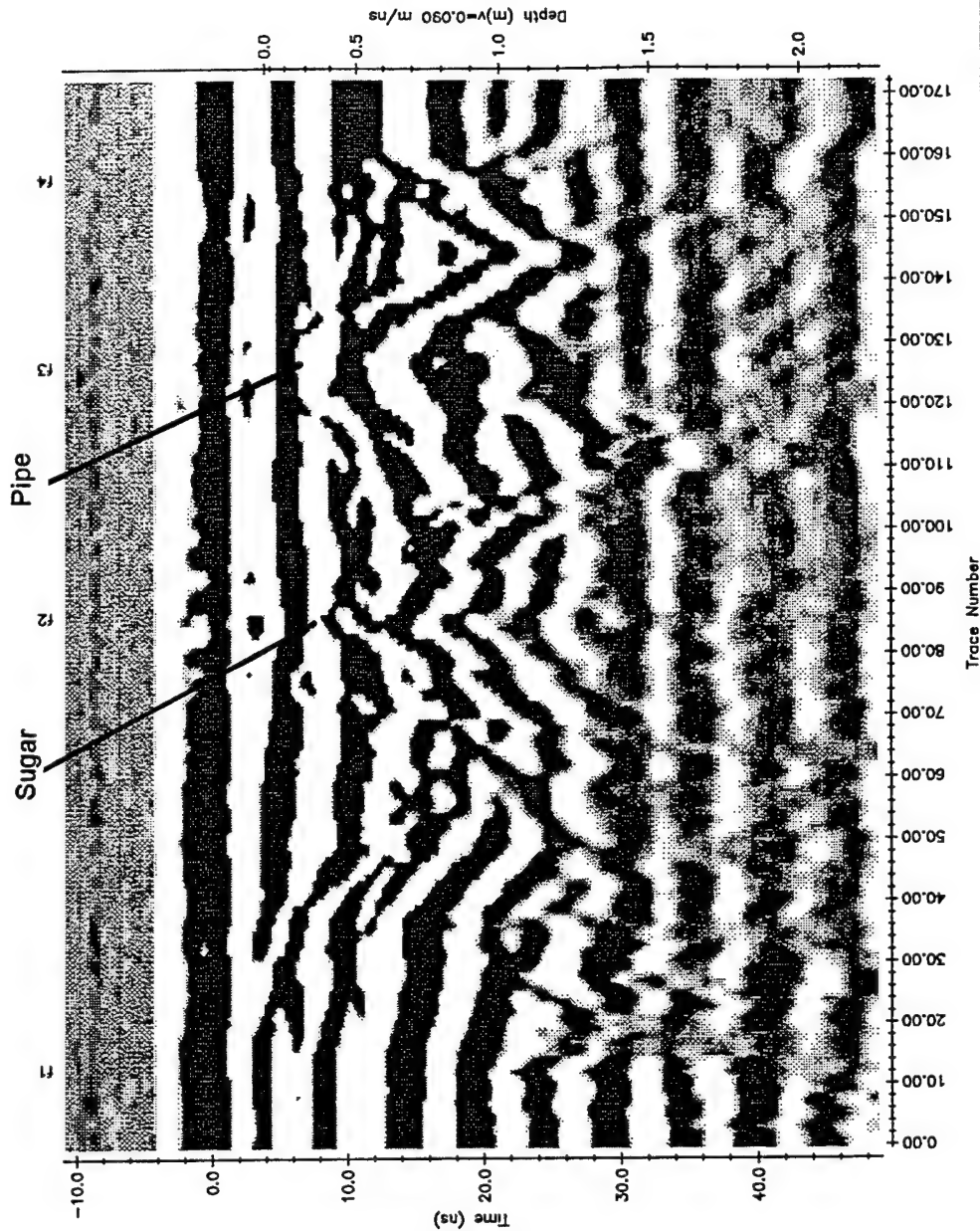
PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.0500 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS  
 FILE = e:\COASTG~1\21SEP0~1\F0225PS2  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Powered Gypsum Pile, 225 MHz, Sugar - Profile Over Sugar  
 DATE = 21/09/10  
 NUMBER OF TRACES = 173  
 NUMBER OF PTS/TRC = 200  
 TIMEZERO AT POINT = 37  
 TOTAL TIME WINDOW = 60  
 STARTING POSITION = 0.000  
 FINAL POSITION = 172.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 225.00  
 ANTENNA SEPARATION = 0.500  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 4  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971195/96

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -11 to 49  
 POSITIONS: 0.000 to 172.000  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.0600 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



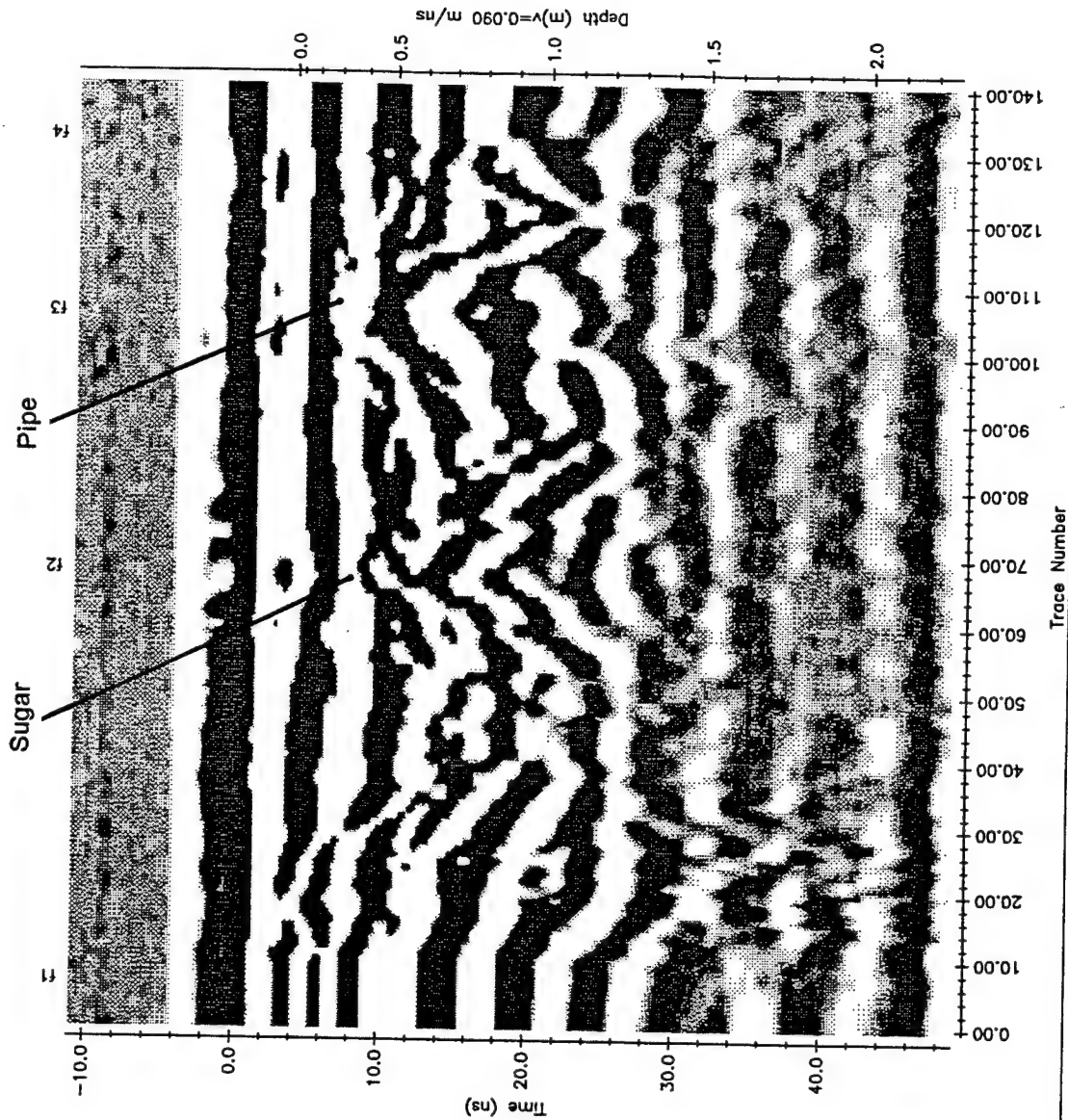
pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\21SEP0~1\CG225PS3  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Powered Gypsum Pipe, 225 MHz, Sugar - Profile Over Sugar  
 DATE = 21/09/10  
 NUMBER OF TRACES = 141  
 NUMBER OF PTS/TRC = 200  
 TIMEZERO AT POINT = 37  
 TOTAL TIME WINDOW = 60  
 STARTING POSITION = 0.000  
 FINAL POSITION = 140.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 225.00  
 ANTENNA SEPARATION = 0.500  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 4  
 SURVEY MODE = Reflection  
 COLLECTED BY PET000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971195/96

#### PROCESSING SELECTED

FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -11 to 49  
 POSITIONS: 0.000 to 140.000  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

#### PLOT LAYOUT PARAMETERS

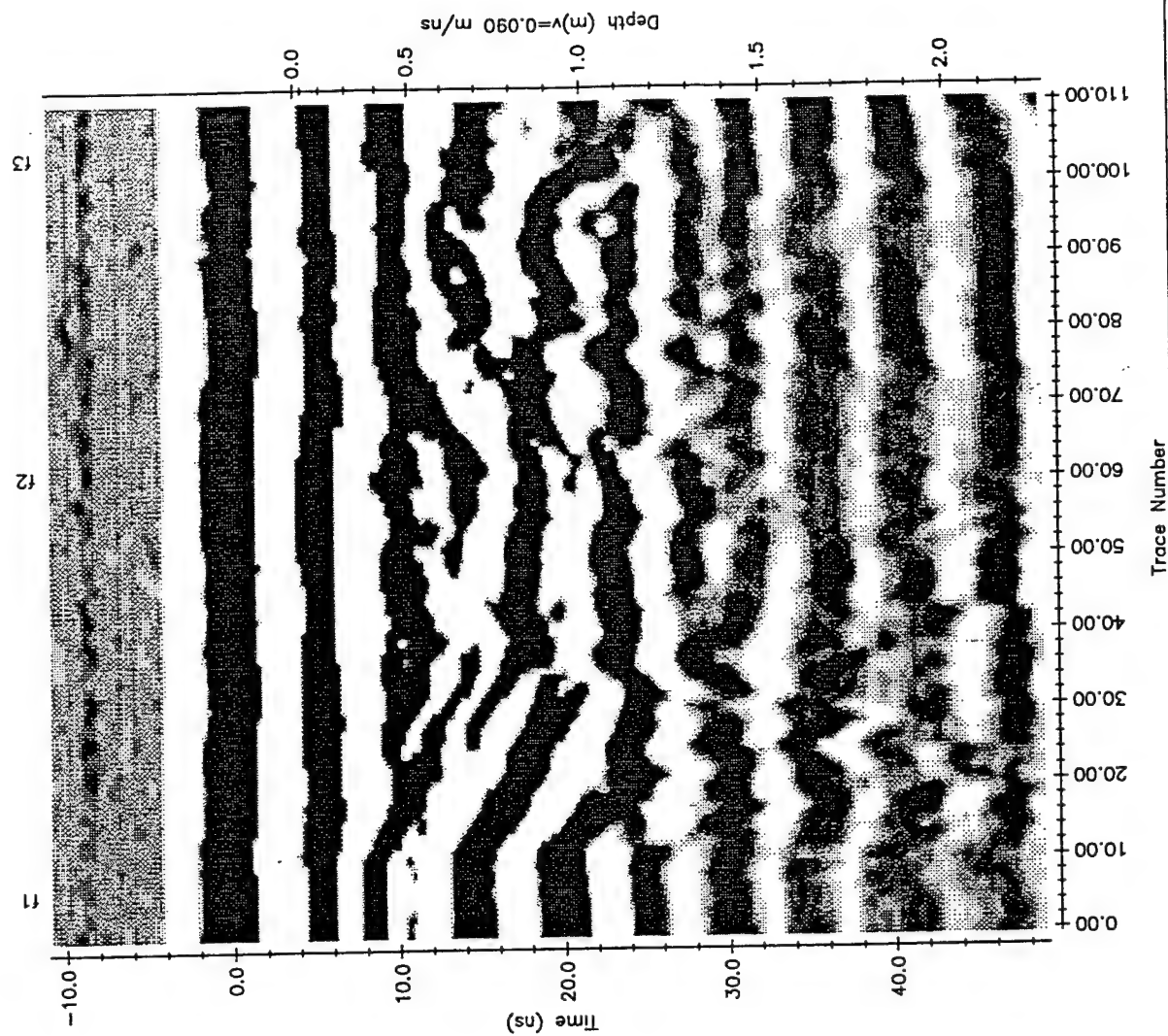
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 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\21SEP0~1\CG225PS4  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Powered Gypsum Pile, 225 MHz, Sugar - East Edge of Pile  
 DATE = 21/09/10  
 NUMBER OF TRACES = 111  
 NUMBER OF PTS/TRC = 200  
 TIMEZERO AT POINT = 37  
 TOTAL TIME WINDOW = 60  
 STARTING POSITION = 0.000  
 FINAL POSITION = 110.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 225.00  
 ANTENNA SEPARATION = 0.500  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 4  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971195/96

PROCESSING SELECTED  
 FILTERS: TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -11 to 49  
 SELECTION POSITIONS: 0.000 to 110.000  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.0600 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0

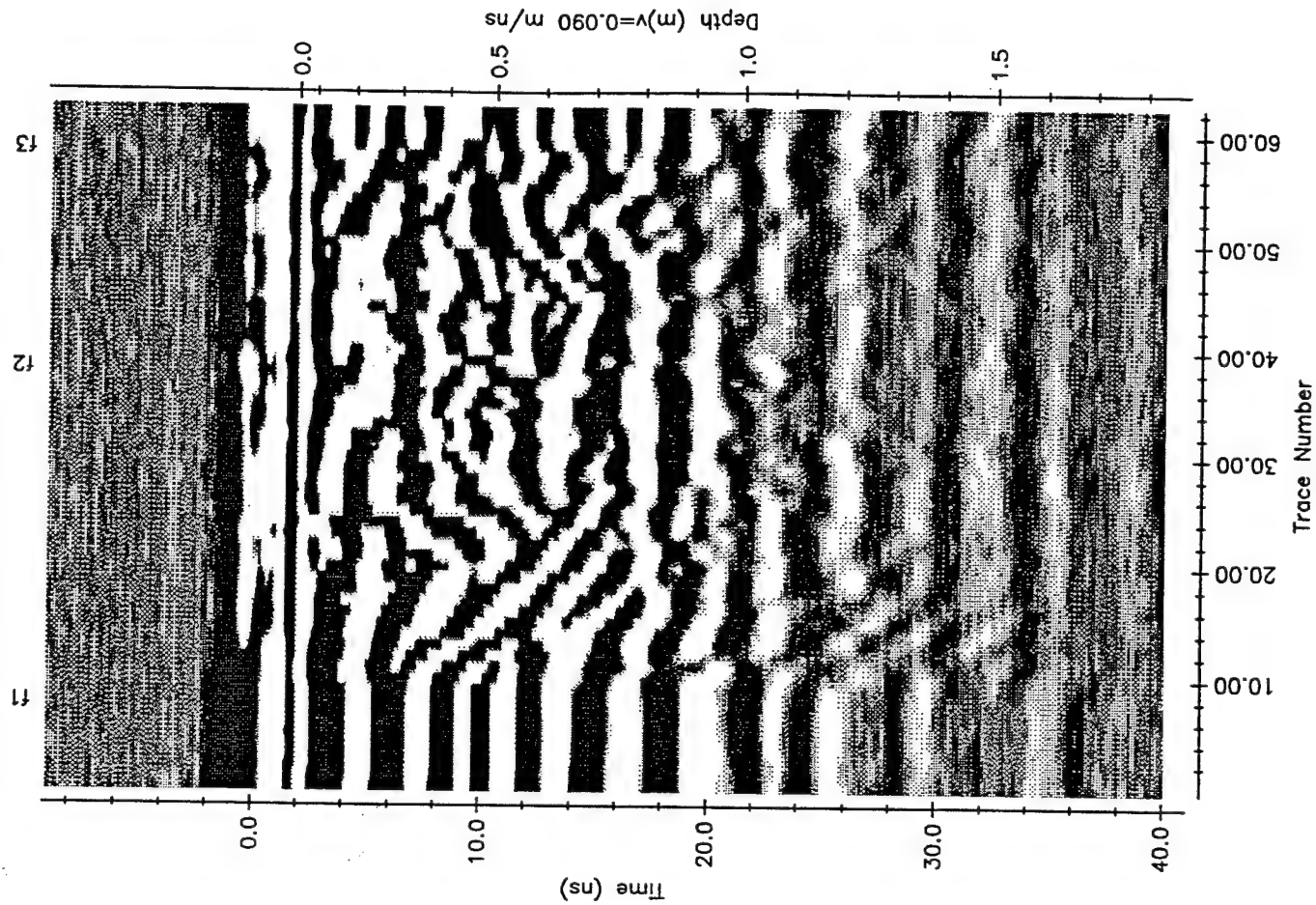




pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\21SEP0~1\CG450PS1  
 JOB# =  
 TITLE = Alabama Shipyard, Bulk Handling Area  
 DATE = 21/09/10  
 TIMEZERO AT POINT = 63  
 NUMBER OF PTS/TRC = 500  
 TOTAL TIME WINDOW = 99  
 STARTING POSITION = 50  
 FINAL POSITION = 0.000  
 STEP SIZE USED = 62.000  
 POSITION UNITS = 1.000  
 NOMINAL FREQUENCY = metres  
 ANTENNA SEPARATION = 450.00  
 PULSER VOLTAGE = 0.250  
 NUMBER OF STACKS = 200  
 SURVEY MODE = 4  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971181/82

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 SELECTION  
 TIME: -9 to 41  
 POSITIONS: 0.000 to 62.000  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

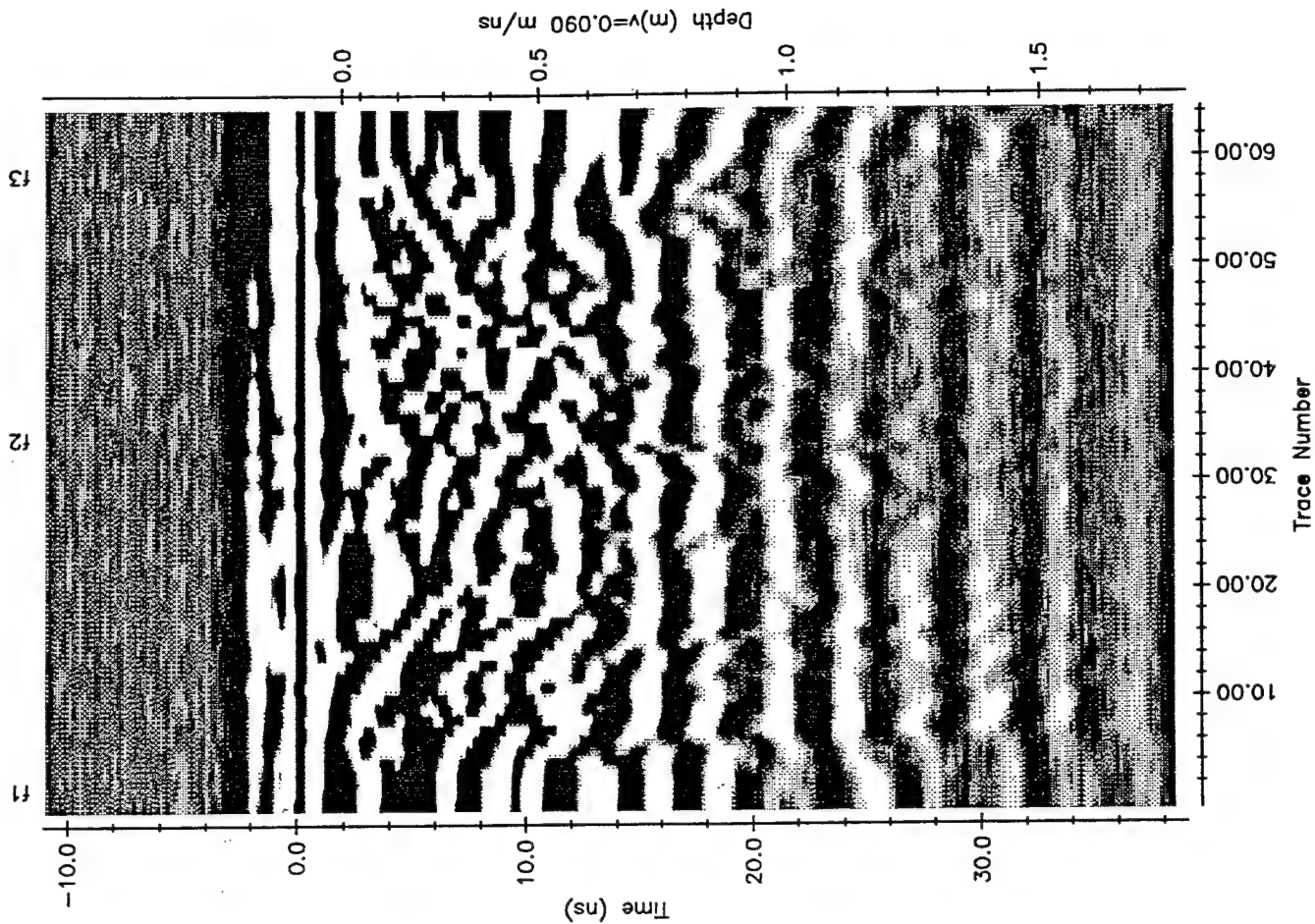
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 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\21SEP0~1\CG450PS2  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Powered Gypsum Pile, 450 MHz, Sugar - Profile Over Sugar  
 DATE = 21/09/10  
 NUMBER OF TRACES = 65  
 NUMBER OF PTS/TRC = 500  
 TIMEZERO AT POINT = 115  
 TOTAL TIME WINDOW = 50  
 STARTING POSITION = 0.000  
 FINAL POSITION = 64.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 450.00  
 ANTENNA SEPARATION = 0.250  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 4  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971181/82

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -11 to 39  
 POSITIONS: 0.000 to 64.000  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

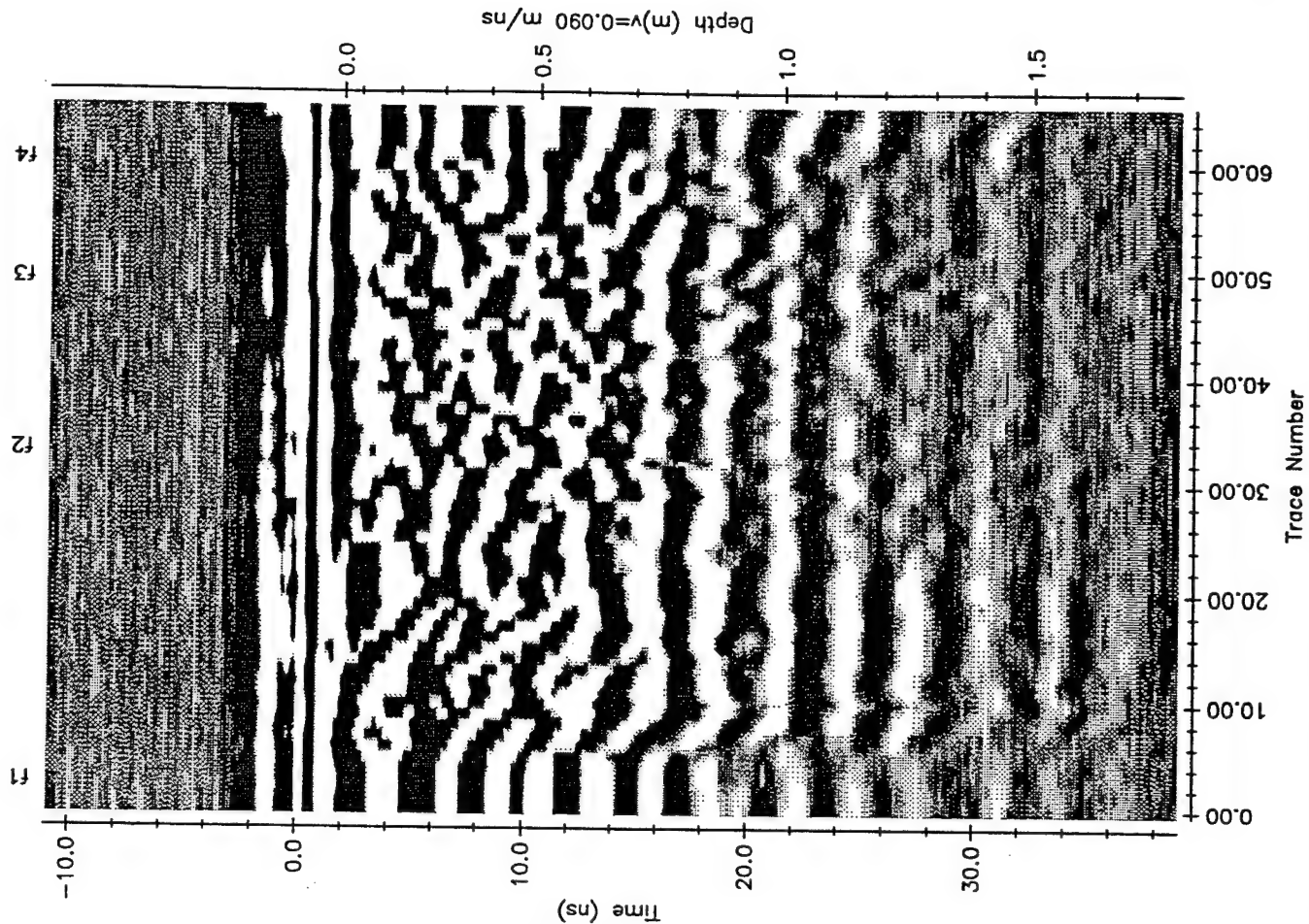
PLOT LAYOUT PARAMETERS  
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 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\21SEP0~1\CG450PS3  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Powered Gypsum Pile, 450 MHz, Sugar' -- Profile Over Sugar  
 DATE = 21/09/10  
 NUMBER OF TRACES = 66  
 NUMBER OF PTS/TRC = 500  
 TIMEZERO AT POINT = 110  
 TOTAL TIME WINDOW = 50  
 STARTING POSITION = 0.000  
 FINAL POSITION = 65.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 450.00  
 ANTENNA SEPARATION = 0.250  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 4  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971181/82

PROCESSING SELECTED  
 FILTERS: TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 SELECTION TIME: -11 to 39  
 POSITIONS: 0.000 to 65.000  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

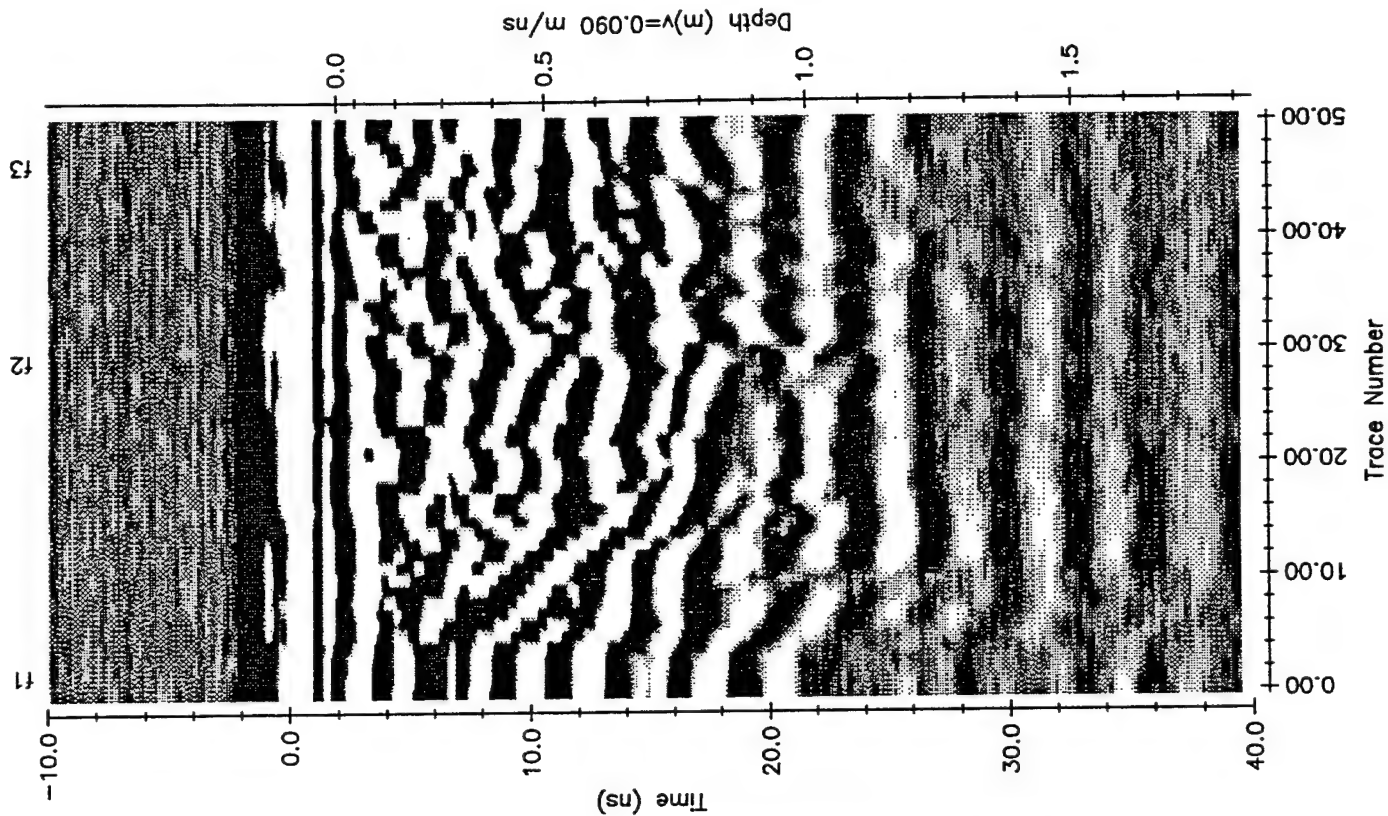
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 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\21SEP0~1\CG450PS4  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Powered Gypsum Pile, 450 MHz, Sugar - East Edge of Pile  
 DATE = 21/09/10  
 NUMBER OF TRACES = 51  
 NUMBER OF PTS/TRC = 500  
 TIMEZERO AT POINT = 105  
 TOTAL TIME WINDOW = 50  
 STARTING POSITION = 0.000  
 FINAL POSITION = 50.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 450.00  
 ANTENNA SEPARATION = 0.250  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 4  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971181/82

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -10 to 40  
 POSITIONS: 0.000 to 50.000  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

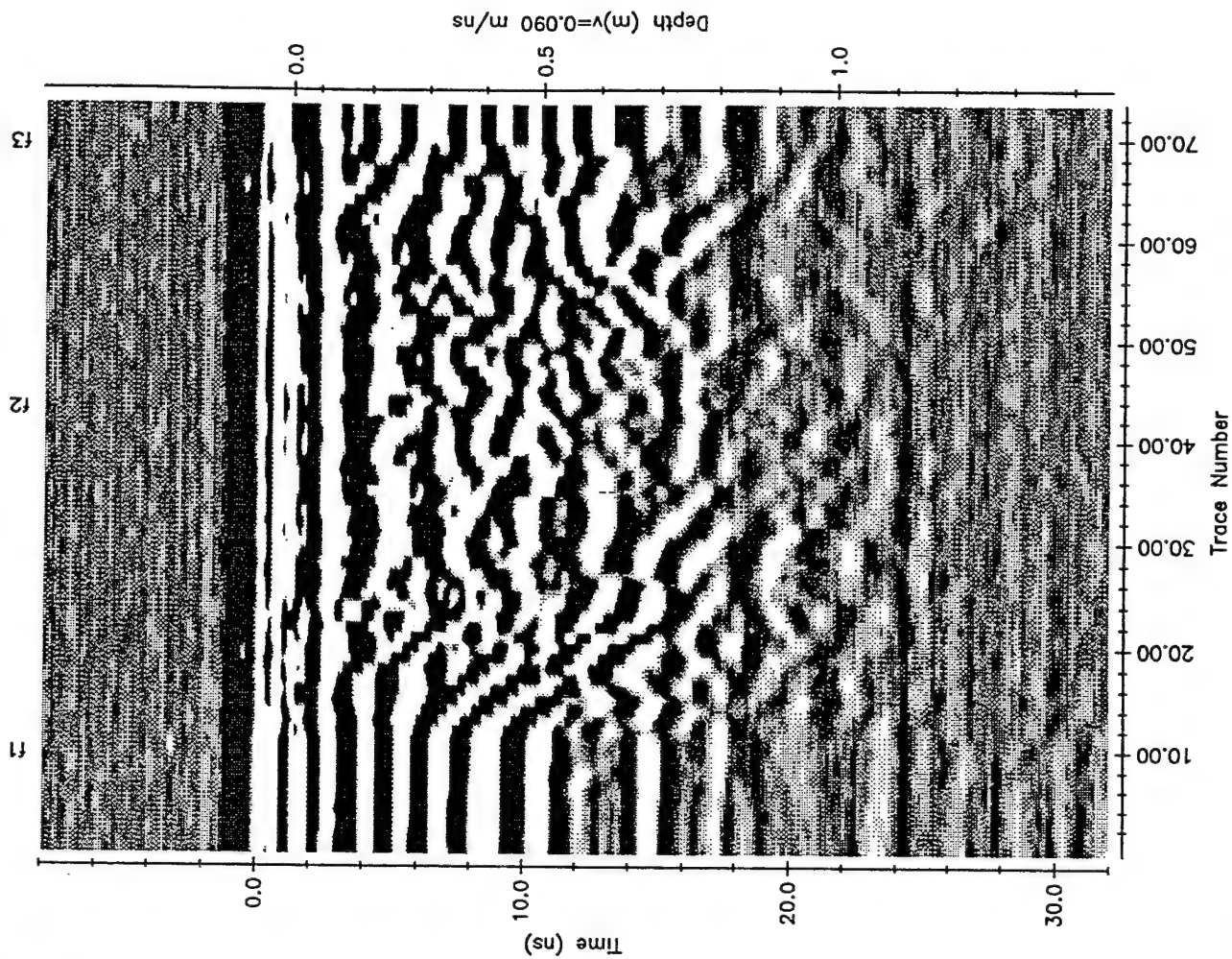
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 TRACE SPACING AND WIDTH: 0.0750 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\21SEP0~1\CG900PS1  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Powered Gypsum Pile, 900 MHz, Sugar - West Edge of Pile  
 DATE = 21/09/10  
 NUMBER OF TRACES = 74  
 NUMBER OF PTS/TRC = 400  
 TIMEZERO AT POINT = 80  
 TOTAL TIME WINDOW = 40  
 STARTING POSITION = 0.000  
 FINAL POSITION = 73.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 900.00  
 ANTENNA SEPARATION = 0.170  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 4  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971258/59

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 SELECTION TIME: -8 to 32  
 POSITIONS: 0.000 to 73.000  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.0750 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0





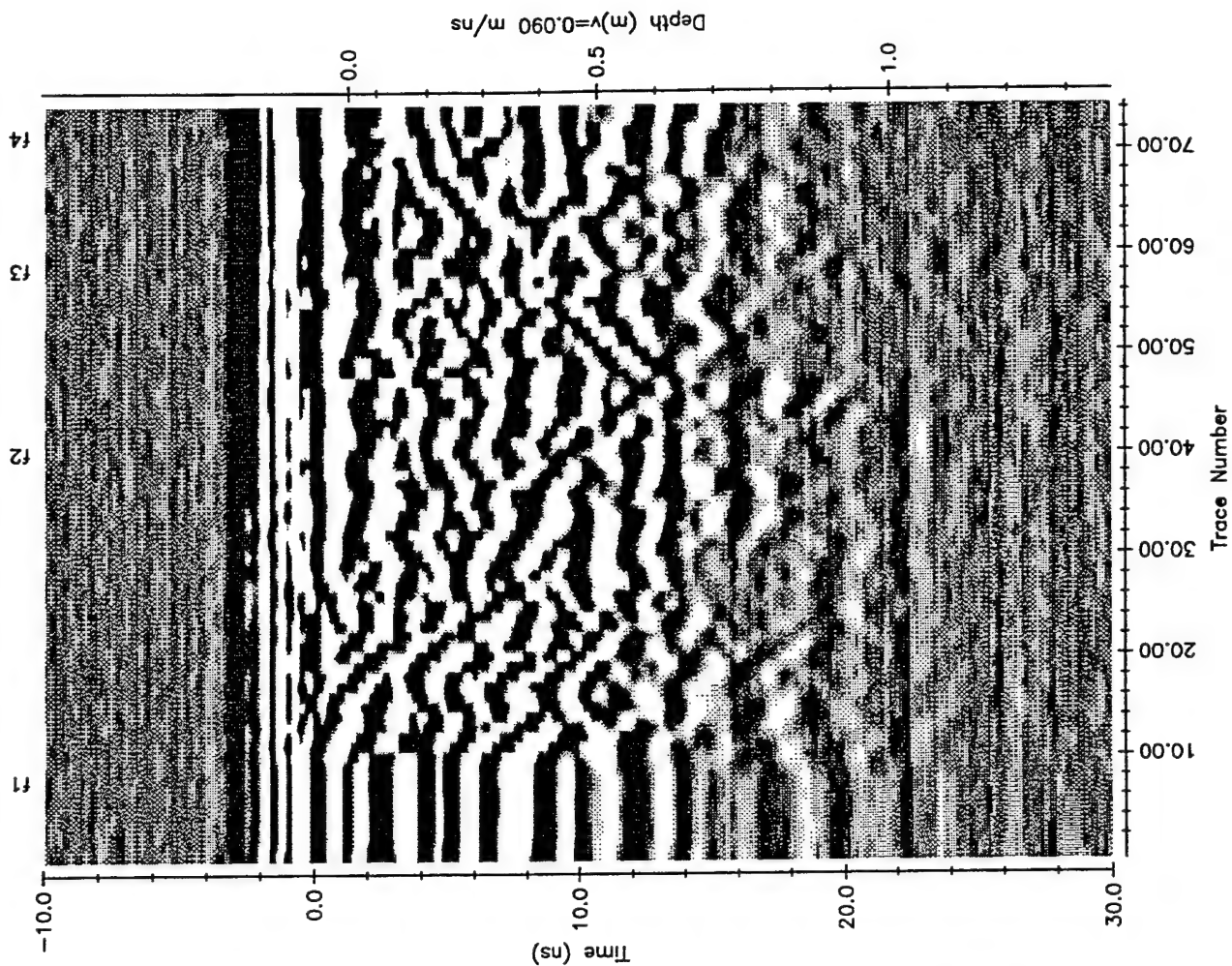
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 FILE = s:\COASTG~1\21SEP0~1\CG900PS2  
 JOB# =  
 TITLE = Alabama Shipyard, Bulk Handling Area  
 TITLE = Powered Gypsum Pile, 900 MHz, Sugar -- Profile Over Sugar  
 DATE = 21/09/10  
 NUMBER OF TRACES = 75  
 NUMBER OF PTS/TRC = 400  
 TIMEZERO AT POINT = 100  
 TOTAL TIME WINDOW = 40  
 STARTING POSITION = 0.000  
 FINAL POSITION = 74.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 900.00  
 ANTENNA SEPARATION = 0.170  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 4  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971258/59

#### PROCESSING SELECTED

FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -10 to 30  
 POSITIONS: 0.000 to 74.000  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

#### PLOT LAYOUT PARAMETERS

TRACE SPACING AND WIDTH: 0.0750 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0

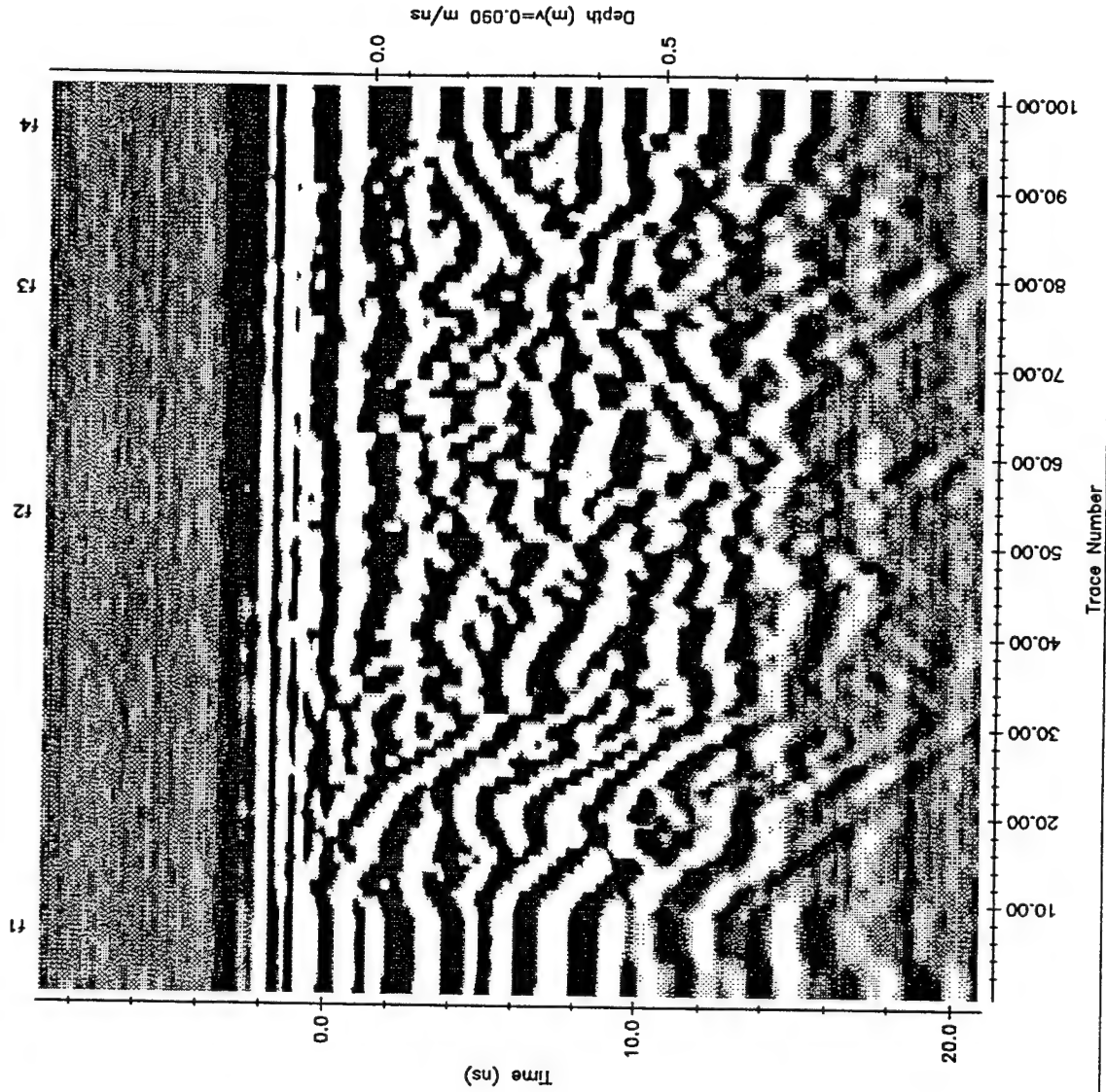




pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\21SEP0~1\CG900PS3  
 JOB# =  
 TITLE = Alabama Shipyard, Bulk Handling Area  
 TITLE = Powered Gypsum Pile, 900 MHz, Sugar - Profile Over Sugar  
 DATE = 21/09/10  
 NUMBER OF TRACES = 102  
 NUMBER OF PTS/TRC = 300  
 TIMEZERO AT POINT = 91  
 TOTAL TIME WINDOW = 30  
 STARTING POSITION = 0.000  
 FINAL POSITION = 101.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 900.00  
 ANTENNA SEPARATION = 0.170  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 4  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971258/59

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 SELECTION TIME: -9 to 21  
 POSITIONS: 0.000 to 101.000  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

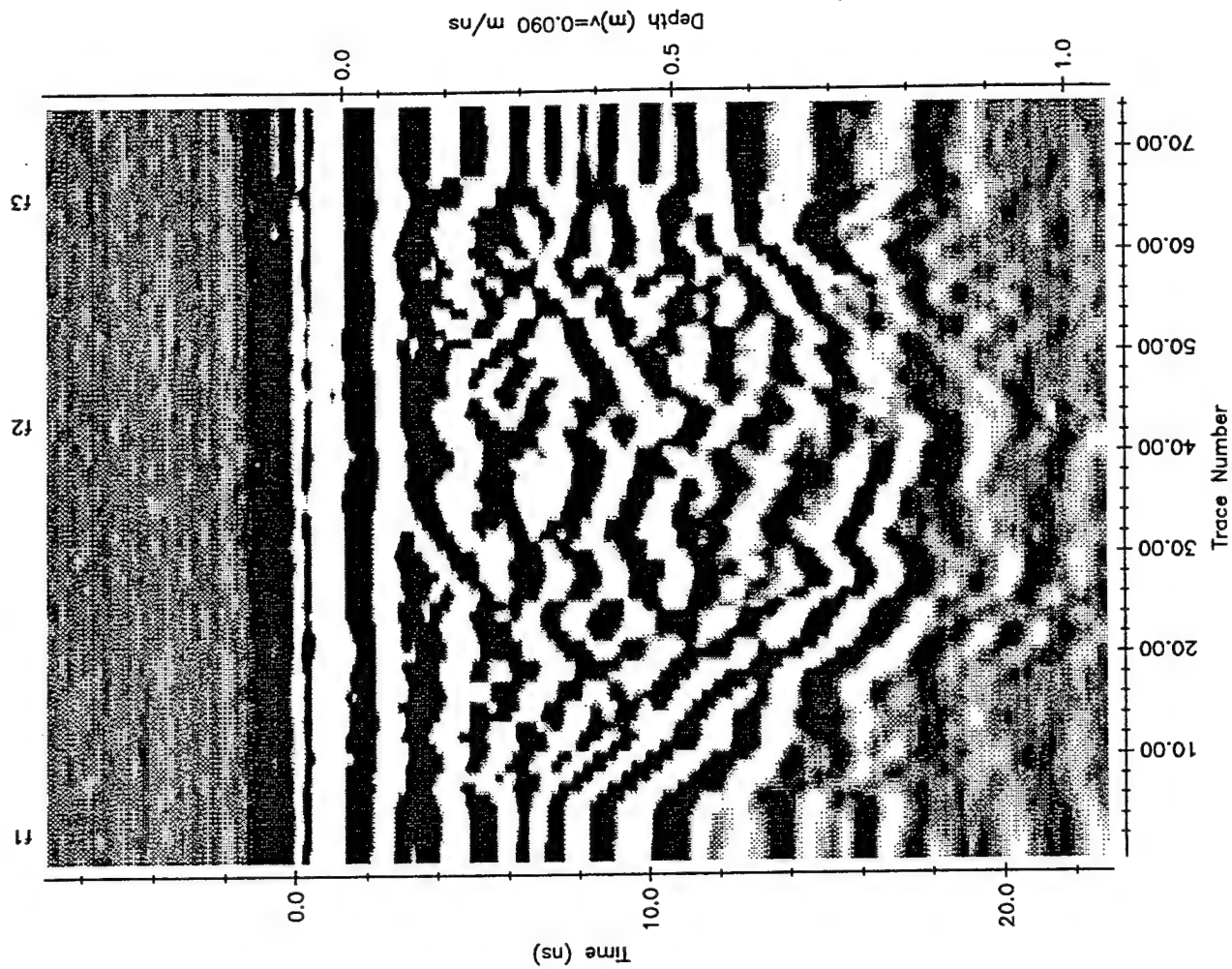
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 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
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 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



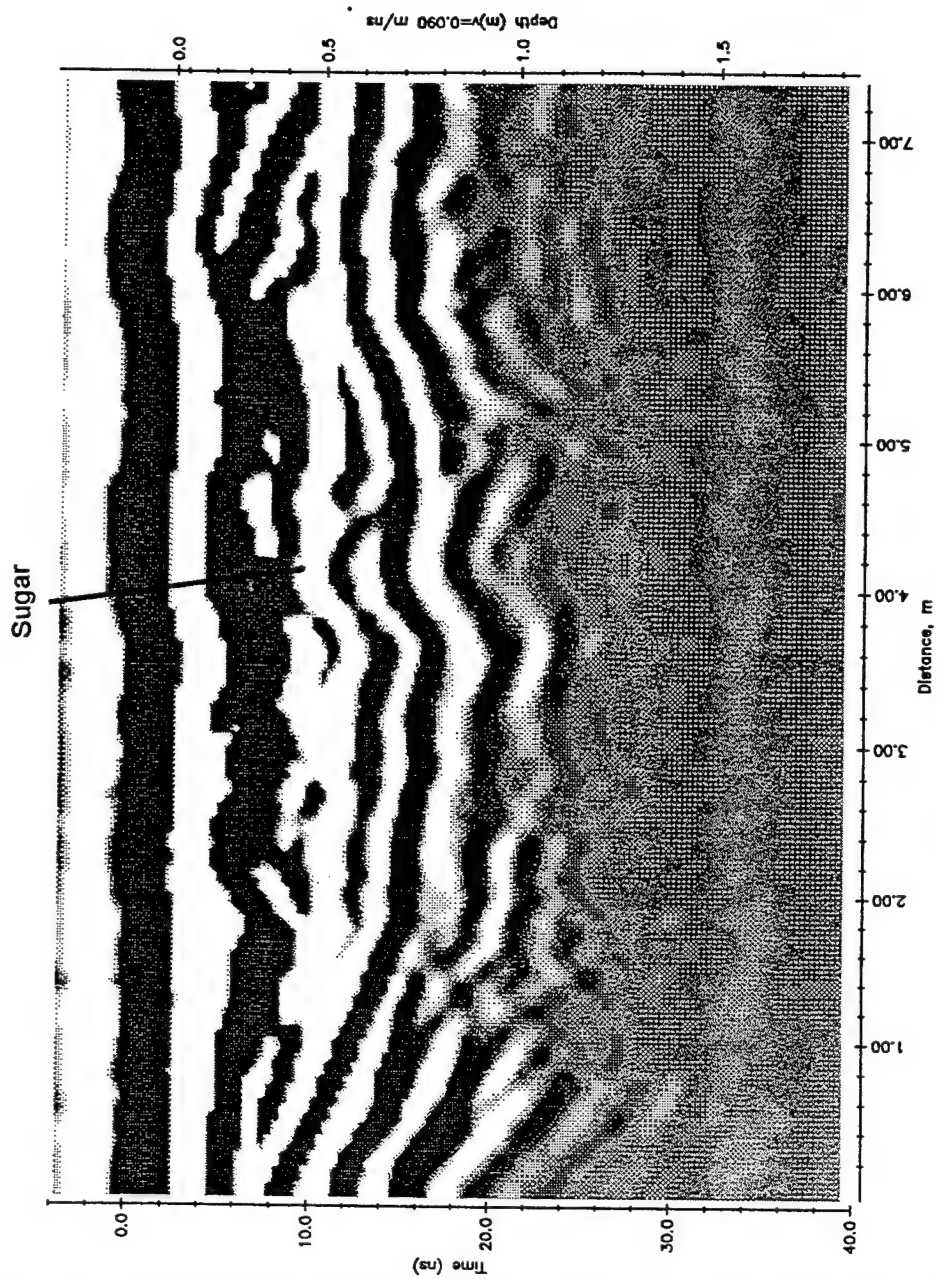
pulseKHO HEADER PARAMETERS  
 FILE = s:\COASTG~1\21SEP0~1\CG900PS4  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Powered Gypsum Pile, 900 MHz, Sugar - East Edge of Pile  
 DATE = 21/09/10  
 NUMBER OF TRACES = 75  
 NUMBER OF PTS/TRC = 300  
 TIMEZERO AT POINT = 71  
 TOTAL TIME WINDOW = 30  
 STARTING POSITION = 0.000  
 FINAL POSITION = 74.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 900.00  
 ANTENNA SEPARATION = 0.170  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 4  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971258/59

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -7 to 23  
 SELECTION  
 POSITIONS: 0.000 to 74.000  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.0750 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0

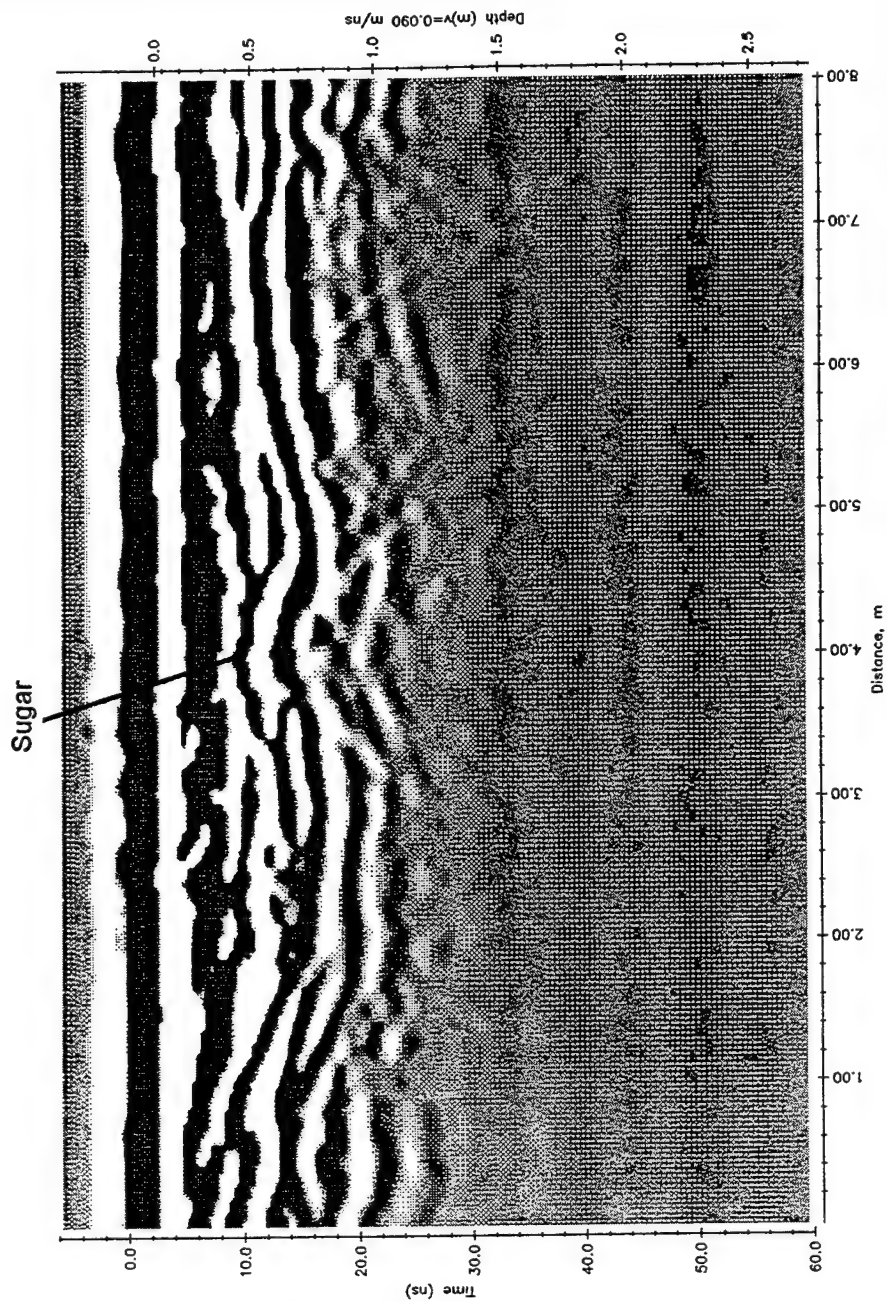


pulseKVO HEADER PARAMETERS  
 JOB# = s:\CONSTG~1\Z1SEPO~1\CG250PSO  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Roadbed Gypsum Pile, 250 MHz, Sugar - West Edge of Pile  
 DATE = 09/21/20  
 NUMBER OF TRACES = 148  
 NUMBER OF PTS/TRC = 111  
 TIMEZERO AT POINT = 11  
 TOTAL TIME WINDOW = 44  
 STARTING POSITION = 0.000  
 FINAL POSITION = 7.350  
 STEP SIZE USED = 0.050  
 POSITION UNITS = m  
 NOMINAL FREQUENCY = 250.00  
 ANTENNA SEPARATION = 0.305  
 PULSER VOLTAGE = 100  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -4 to 40  
 SELECTION  
 POSITIONS: 0.000 to 7.350  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000  
 PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.0750 and 0.2500  
 MARGIN BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.000  
 BORDER SIZE: 10.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTC~1\215EPO~1\CG250PS1  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Powdered Gypsum Pile, 250 MHz, Sugar - Profile Over Sugar  
 DATE = 09/11/83  
 NUMBER OF TRACES = 161  
 NUMBER OF PLS/TRC = 16  
 TIME ZERO AT POINT = 66  
 TOTAL TIME WINDOW = 0.000  
 STARTING POSITION = 8.000  
 FINAL POSITION = 0.050  
 STEP SIZE USED = m  
 POSITION UNITS = 250.00  
 NOMINAL FREQUENCY = 250.00  
 ANTENNA SEPARATION = 0.005  
 ANTENNA VOLTAGE = 10.0  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT DIFFERENCING: N  
 CORRECTION: DEWOW  
 SELECTION  
 POSITIONS: 0.000 to 8.000  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

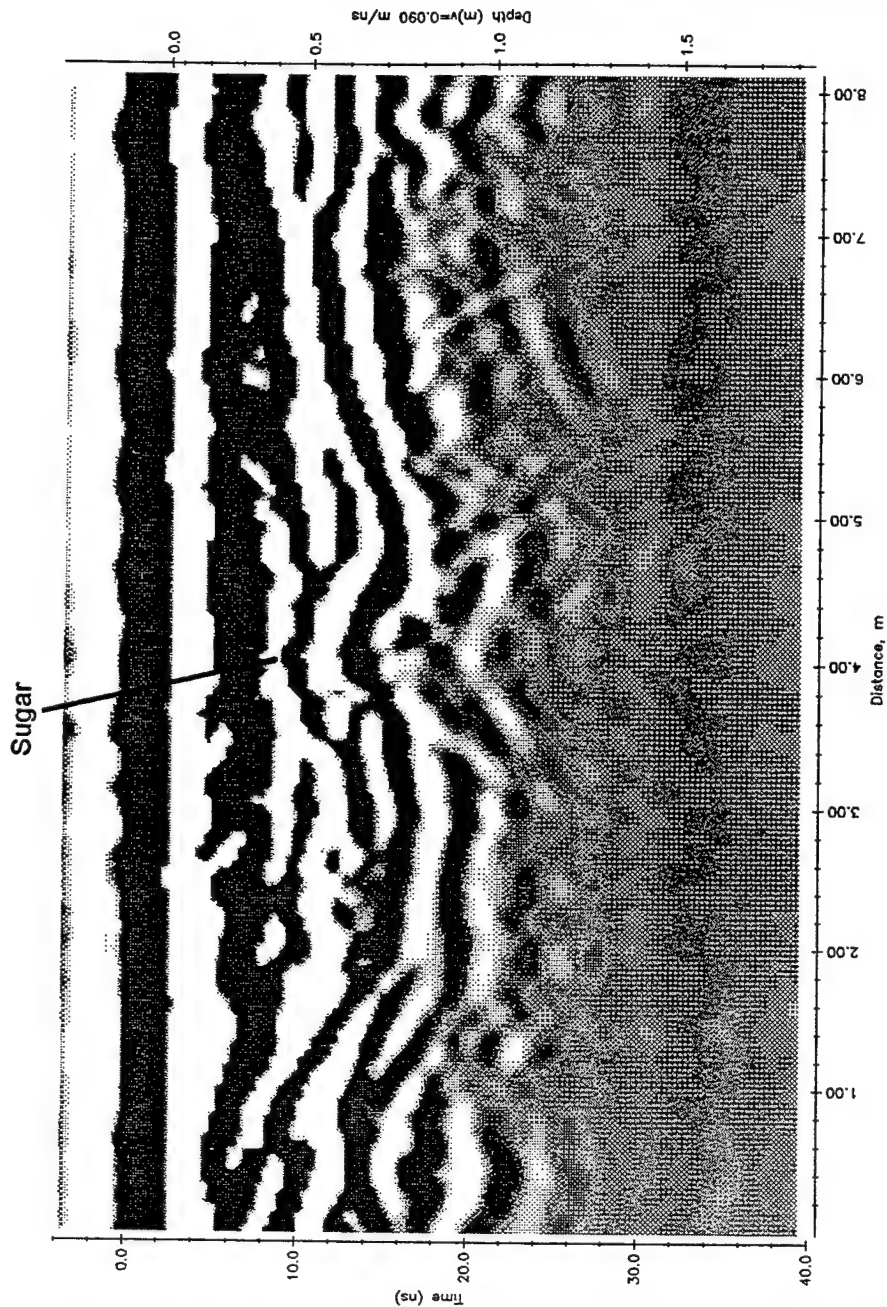
PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.0750 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name: GREY Type: EA Expansion: 0.500 Contour: 0



pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\21SEP0~1\CG250PS2  
 JOB = Alabama Shipyard, Bulk Handling Area  
 TITLE = Powdered Gypsum Pile, 250 MHz, Sugar - Profile Over Sugar  
 DATE = 09/21/20  
 NUMBER OF TRACES = 163  
 NUMBER OF PTS/TRC = 11  
 TIMEZERO AT POINT = 44  
 TOTAL TIME WINDOW = 0.000  
 STARTING POSITION = 8.100  
 FINAL POSITION = 0.050  
 STEP SIZE USED = m  
 POSITION UNITS = 250.00  
 ANTENNA FREQUENCY = 0.365  
 ANTENNA SEPARATION = 15  
 PULSER VOLTAGE = 15  
 NUMBER OF STACKS = 15  
 SURVEY MODE = Reflection  
 action

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TIME DIFFERENCING: N  
 CORRECTION: GEMOW  
 SELECTION TIME: -4 to 40  
 POSITIONS: 0.000 to 8.100  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

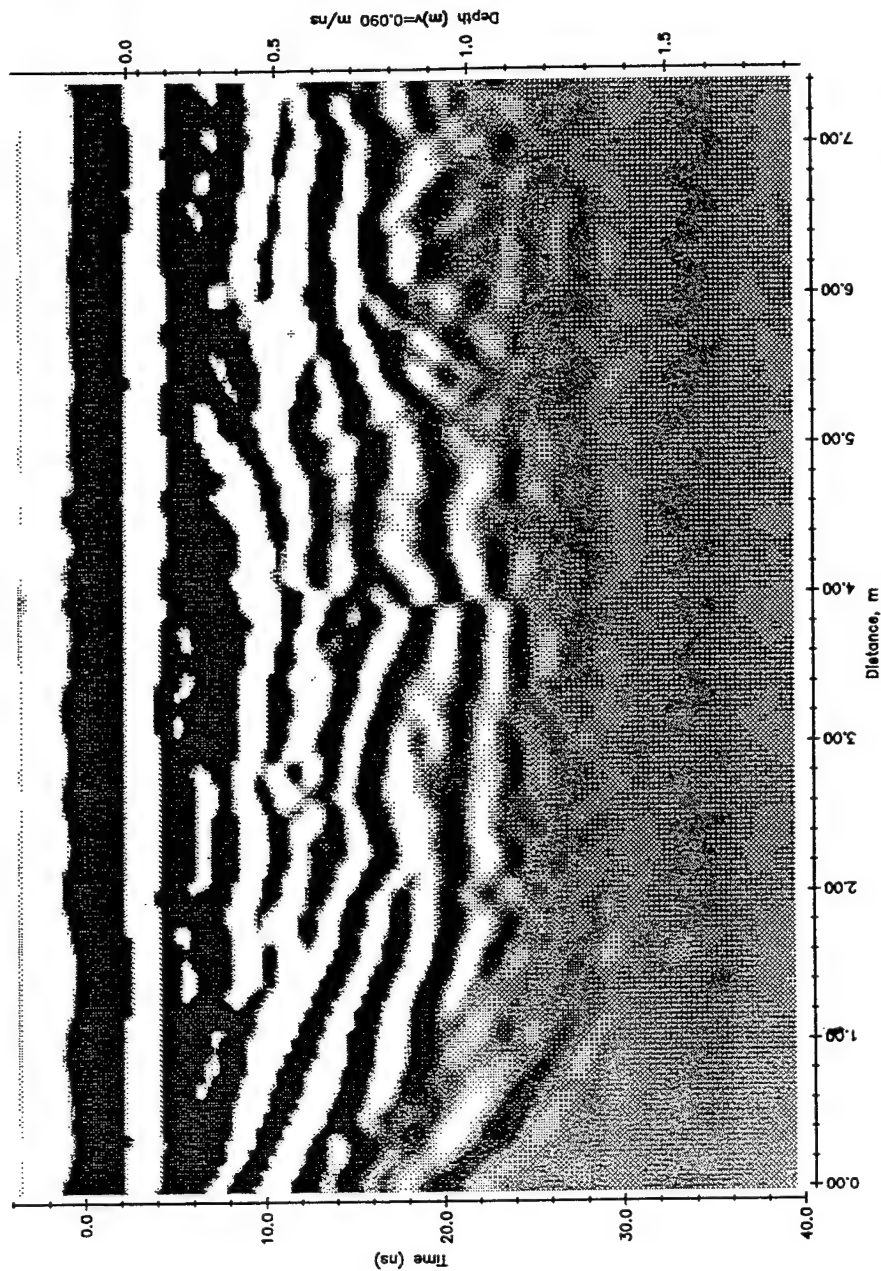
PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.0750 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 BORDER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0





pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG-1\21SEP0-1\CG250PS3  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Powerline, Gypsum Pile, 250 MHz, Sugar - East Edge of Pile  
 DATE = 09/27/20  
 NUMBER OF TRACES = 149  
 NUMBER OF PTS/TRC = 111  
 TIMEZERO AT POINT = 44  
 TOTAL TIME WINDOW = 0.000  
 STARTING POSITION = 7.400  
 FINAL POSITION = 0.050  
 STEP SIZE USED = m  
 POSITION UNITS = 250.00  
 NOMINAL FREQUENCY = 0.305  
 ANTENNA SEPARATION = 100  
 PULSER VOLTAGE = 16  
 NUMBER OF STACKS = Reflection  
 SURVEY MODE =  
 PROCESSING SELECTED  
 FILTERS: TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -4 to 40  
 SELECTION POSITIONS: 0.000 to 7.400  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.0750 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0

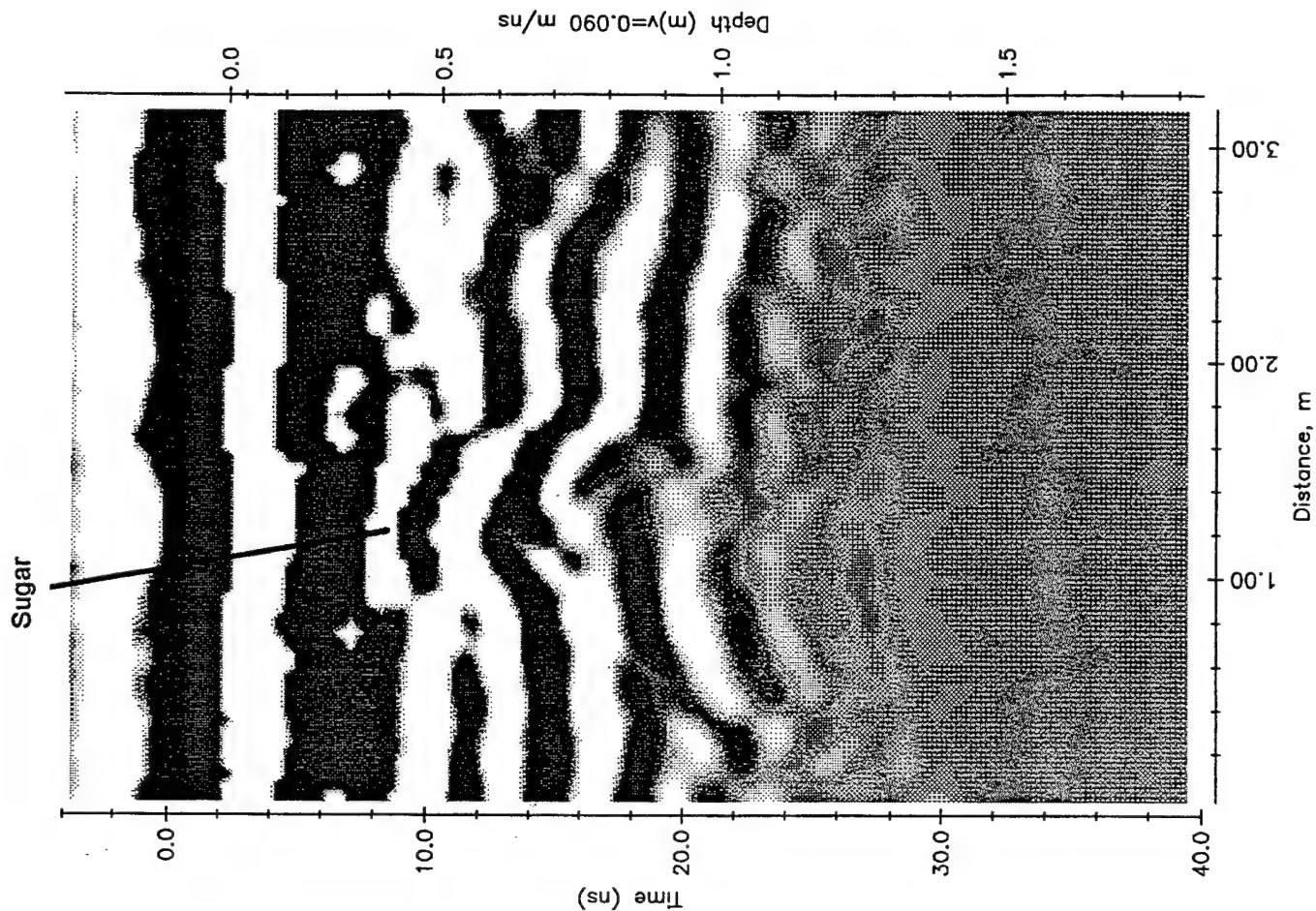




pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\21SEP0~1\CG250PS4  
 JOB# =  
 TITLE = Alabama Shipyard, Bulk Handling Area  
 DATE = 09/21/20  
 NUMBER OF TRACES = 64  
 NUMBER OF PTS/TRC = 111  
 TIMEZERO AT POINT = 11  
 TOTAL TIME WINDOW = 44  
 STARTING POSITION = 0.000  
 FINAL POSITION = 3.150  
 STEP SIZE USED = 0.050  
 POSITION UNITS = m  
 NOMINAL FREQUENCY = 250.00  
 ANTENNA SEPARATION = 0.305  
 PULSER VOLTAGE = 100  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -4 to 40  
 POSITIONS: 0.000 to 3.150  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.0750 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



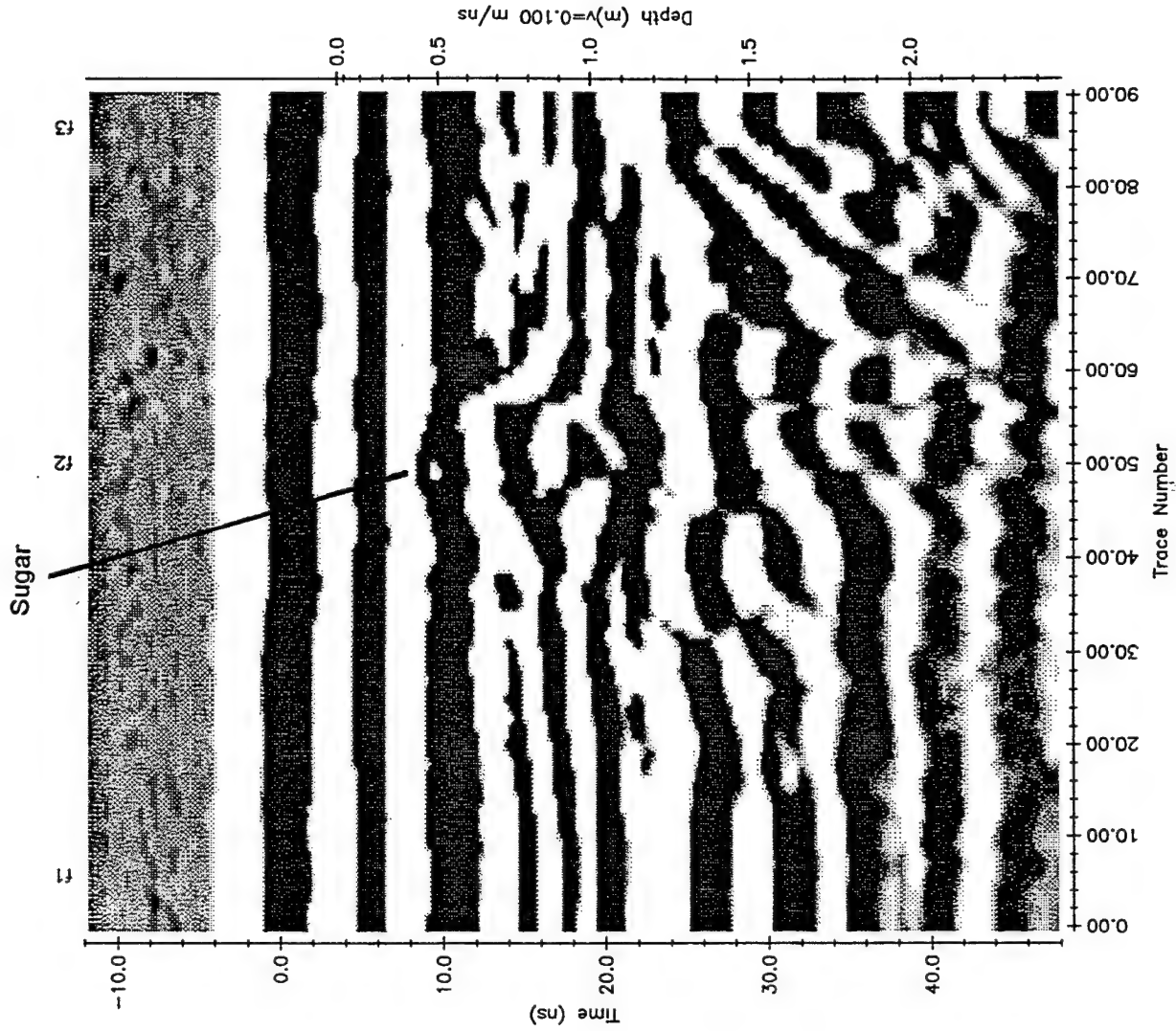
**Appendix G**  
**Crushed Pumice**  
**GPR Records – Buried Contraband**  
**Simulant Test**

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pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\21SEP0~1\CG225MS1  
 JOB# =  
 TITLE = Alabama Shipyard, Bulk Handling Area  
 TITLE = Pumice Pile, 225 MHz, Sugar - Profile Over Sugar  
 DATE = 21/09/10  
 NUMBER OF TRACES = 91  
 NUMBER OF PTS/TRC = 200  
 TIMEZERO AT POINT = 40  
 TOTAL TIME WINDOW = 60  
 STARTING POSITION = 0.000  
 FINAL POSITION = 90.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 225.00  
 ANTENNA SEPARATION = 0.500  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 4  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971195/96

PROCESSING SELECTED  
 FILTERS: TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -12 to 48  
 SELECTION POSITIONS: 0.000 to 90.000  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

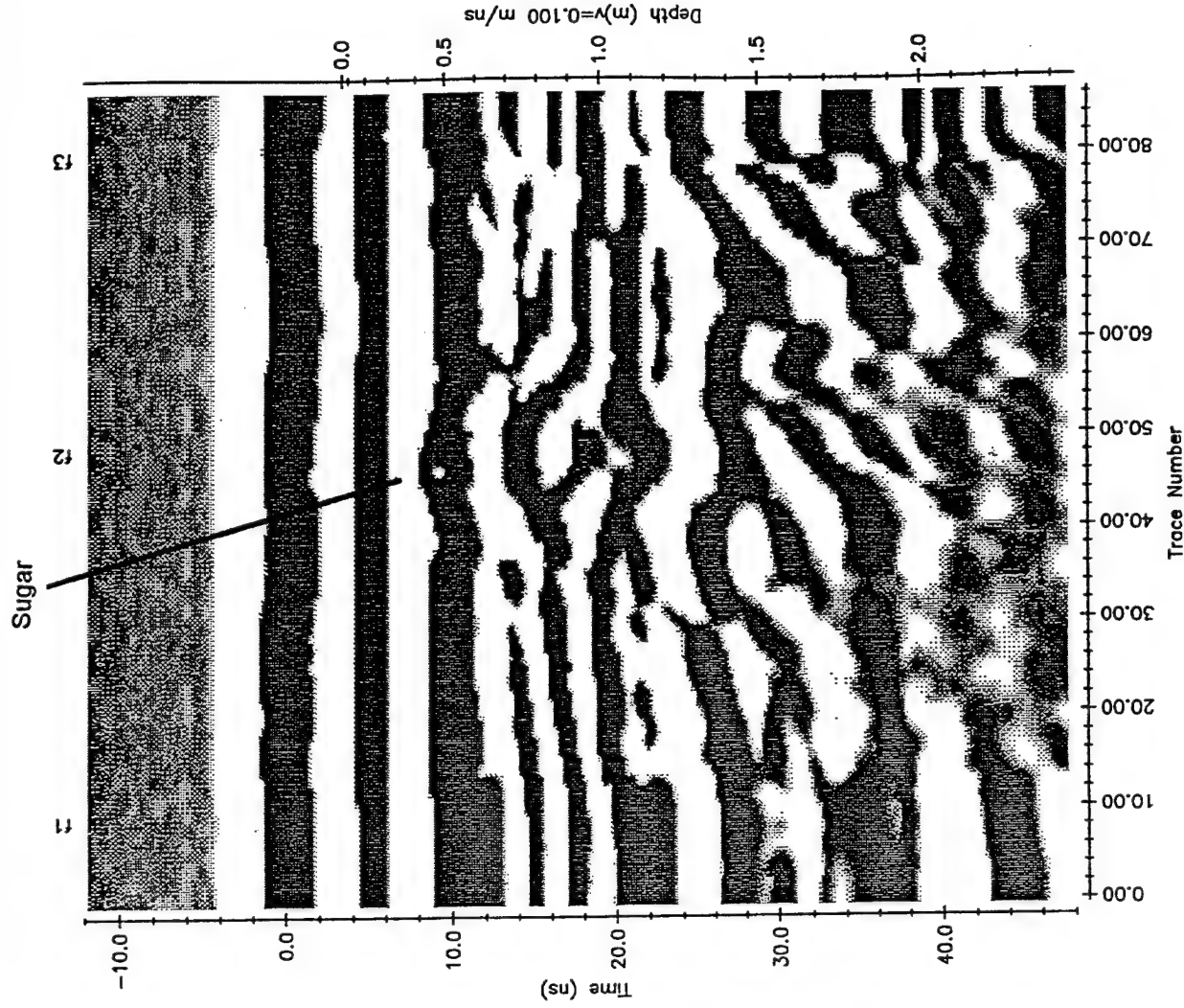
PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.0750 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\21SEP0~1\CG225MS2  
 JOB# =  
 TITLE = Alabama Shipyard, Bulk Handling Area  
 TITLE = Pumice Pile, 225 Mhz, Sugar - Profile Over Sugar  
 DATE = 21/09/10  
 NUMBER OF TRACES = 87  
 NUMBER OF PTS/TRC = 200  
 TIMEZERO AT POINT = 41  
 TOTAL TIME WINDOW = 60  
 STARTING POSITION = 0.000  
 FINAL POSITION = 86.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 225.00  
 ANTENNA SEPARATION = 0.500  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 4  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971195/96

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -12 to 48  
 SELECTION  
 POSITIONS: 0.000 to 86.000  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

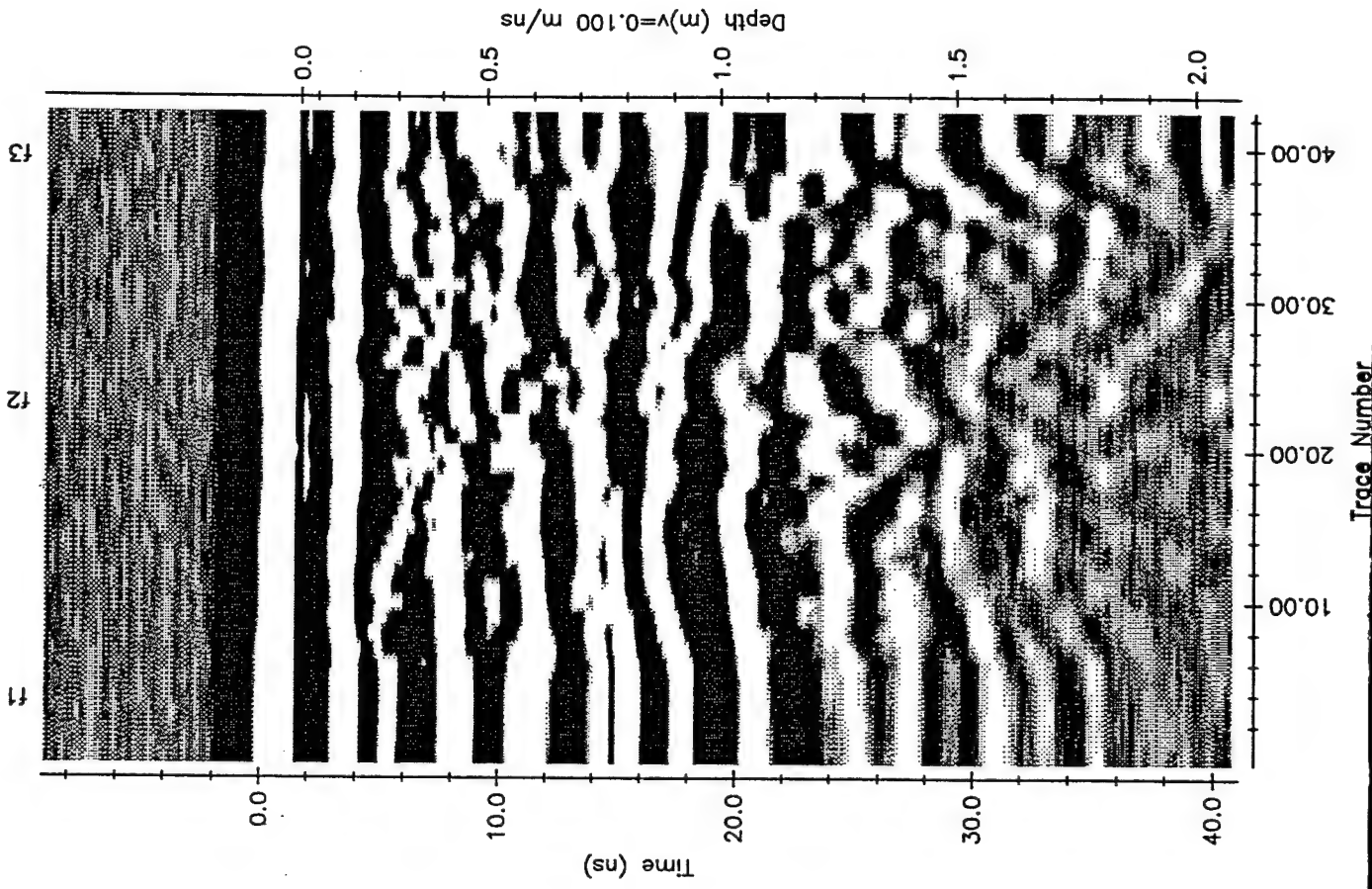
PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.0750 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\21SEP0~1\CG450MS1  
 JOB# =  
 TITLE = Alabama Shipyard, Bulk Handling Area  
 DATE = 21/09/10  
 NUMBER OF TRACES = 43  
 NUMBER OF PTS/TRC = 500  
 TIMEZERO AT POINT = 92  
 TOTAL TIME WINDOW = 50  
 STARTING POSITION = 0.000  
 FINAL POSITION = 42.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 450.00  
 ANTENNA SEPARATION = 0.250  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 4  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971181/82

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -9 to 41  
 SELECTION  
 POSITIONS: 0.000 to 42.000  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

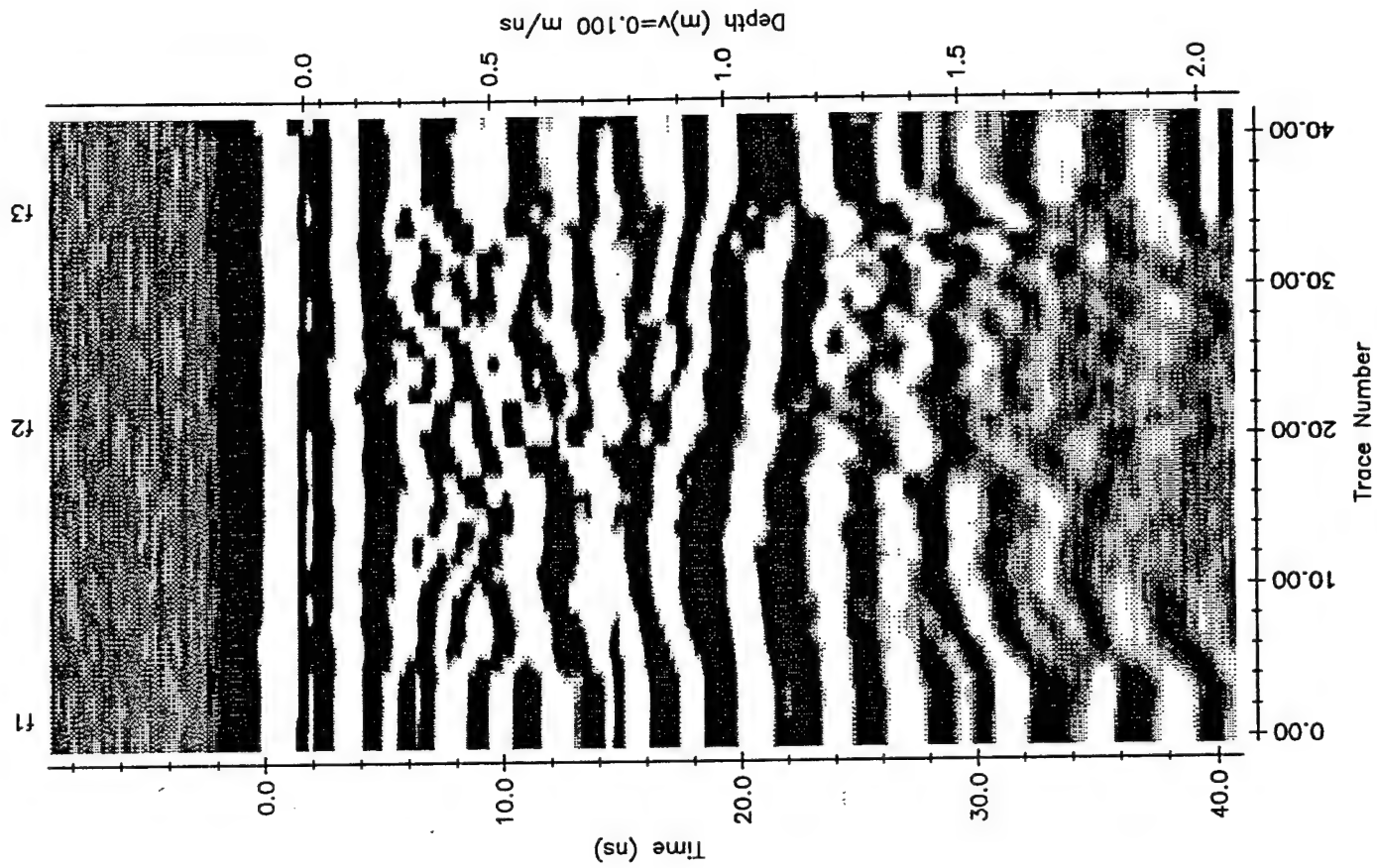
PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.1000 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\21SEP0~1\CG450MS2  
 JOB# =  
 TITLE = Alabama Shipyard, Bulk Handling Area  
 TITLE = Pumice Pile, 450 MHz, Sugar - Profile Over Sugar  
 DATE = 21/09/10  
 NUMBER OF TRACES = 42  
 NUMBER OF PTS/TRC = 500  
 TIMEZERO AT POINT = 92  
 TOTAL TIME WINDOW = 50  
 STARTING POSITION = 0.000  
 FINAL POSITION = 41.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 450.00  
 ANTENNA SEPARATION = 0.250  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 4  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971181/82

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -9 to 41  
 POSITIONS: 0.000 to 41.000  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.1000 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0

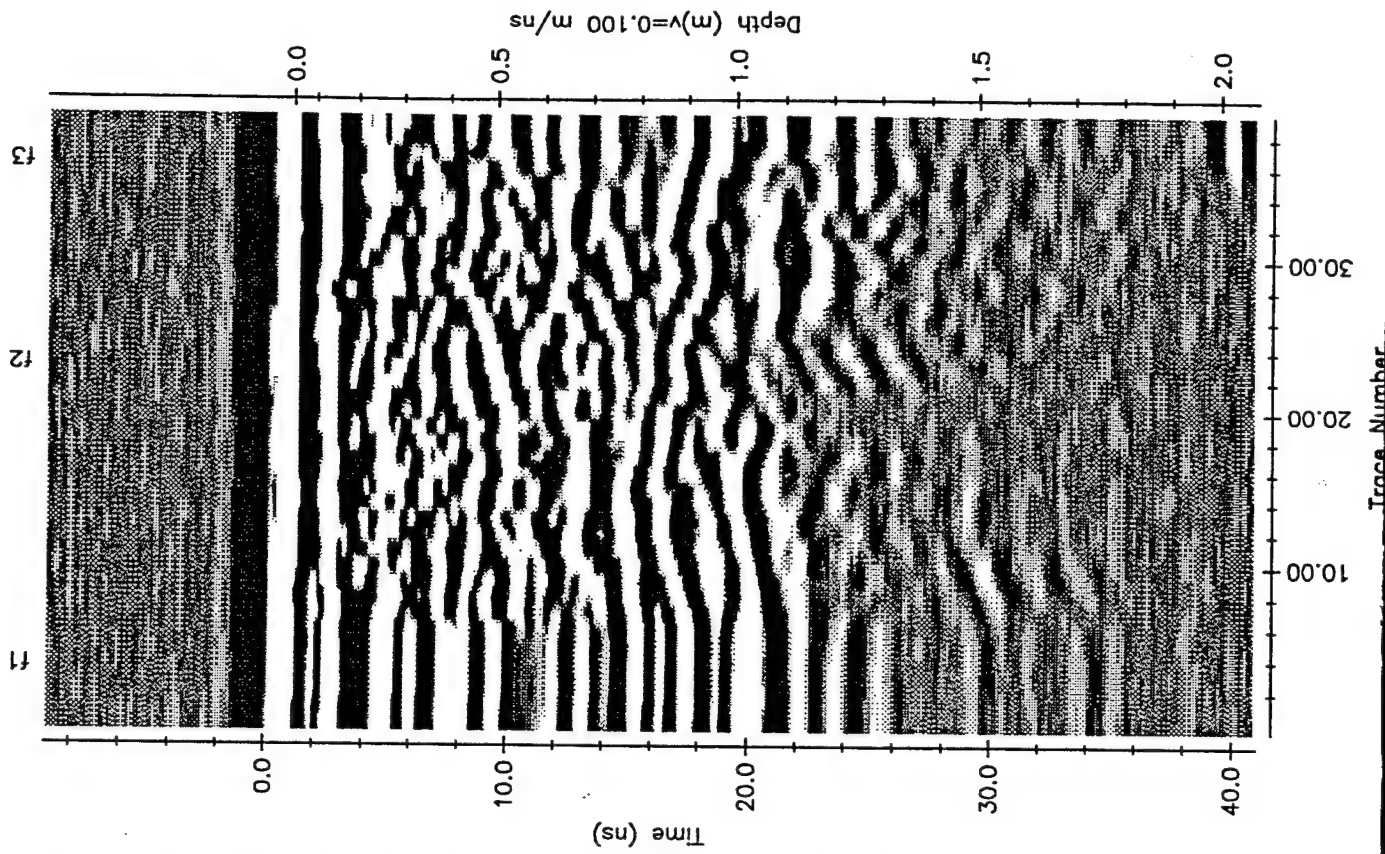




pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\21SEP0~1\CG900MS1  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Pumice Pile, 900 MHz, Sugar - Profile Over Sugar  
 DATE = 21/09/10  
 NUMBER OF TRACES = 40  
 NUMBER OF PTS/TRC = 500  
 TIMEZERO AT POINT = 91  
 TOTAL TIME WINDOW = 50  
 STARTING POSITION = 0.000  
 FINAL POSITION = 39.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 900.00  
 ANTENNA SEPARATION = 0.170  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 4  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971258/59

PROCESSING SELECTED  
 FILTERS: TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -9 to 41  
 POSITIONS: 0.000 to 39.000  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

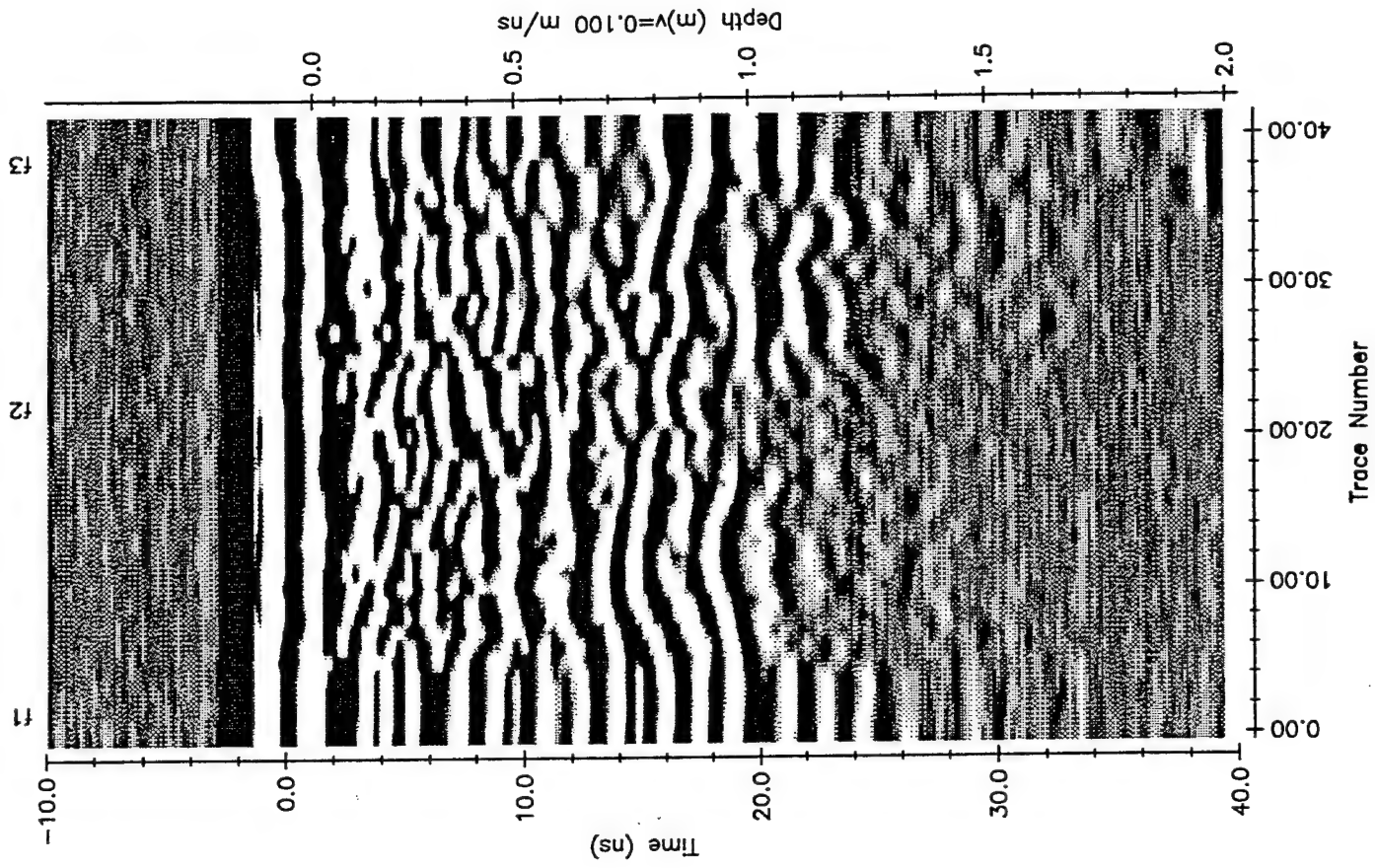
PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.1000 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\21SEP0~1\CG9000MS2  
 JOB# =  
 TITLE = Alabama Shipyard, Bulk Handling Area  
 TITLE = Pumice Pile, 900 MHz, Sugar -- Profile Over Sugar  
 DATE = 21/09/10  
 NUMBER OF TRACES = 42  
 NUMBER OF PTS/TRC = 500  
 TIMEZERO AT POINT = 106  
 TOTAL TIME WINDOW = 50  
 STARTING POSITION = 0.000  
 FINAL POSITION = 41.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 900.00  
 ANTENNA SEPARATION = 0.170  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 4  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971258/59

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 SELECTION TIME: -10 to 40  
 POSITIONS: 0.000 to 41.000  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

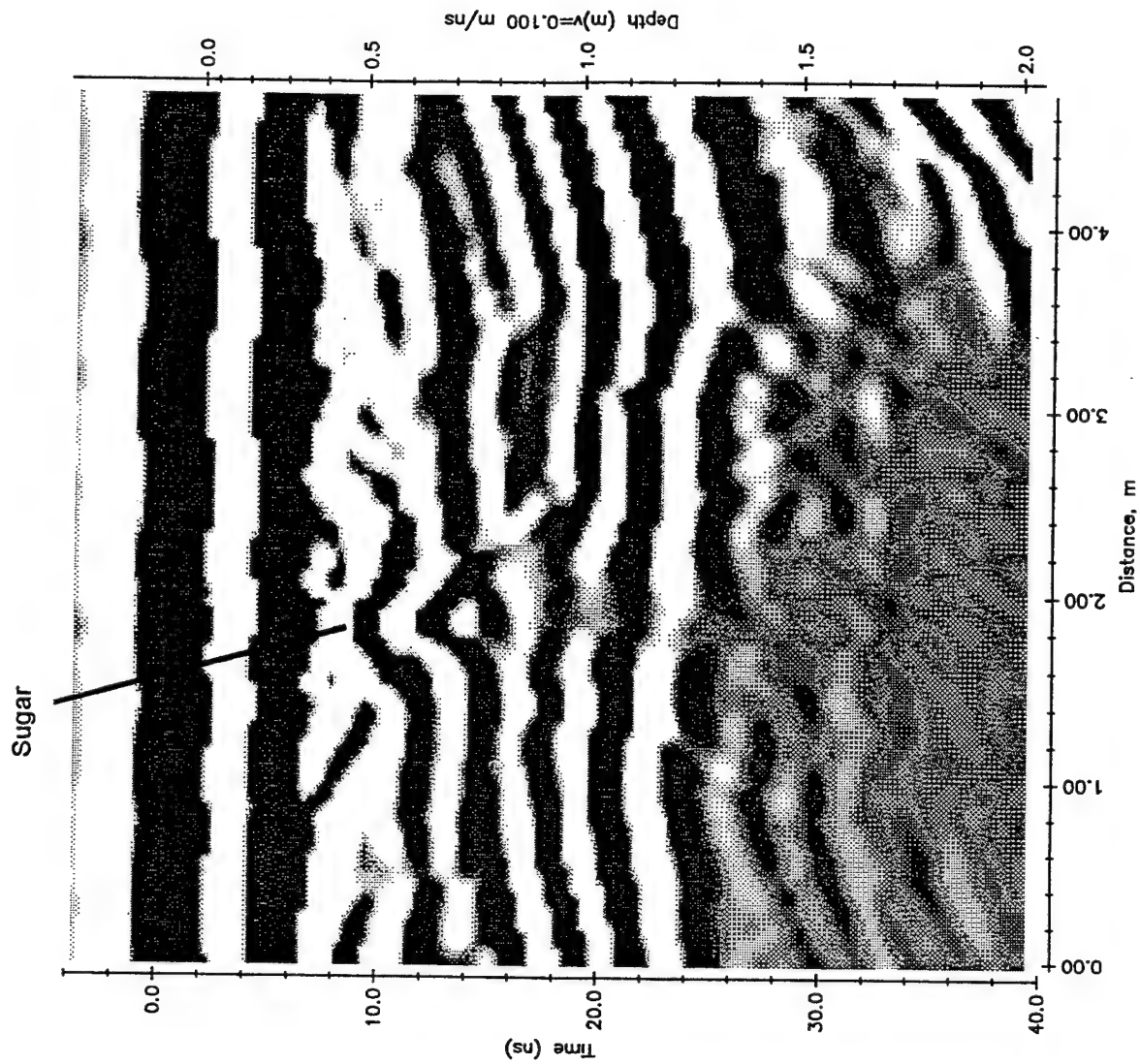
PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.1000 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



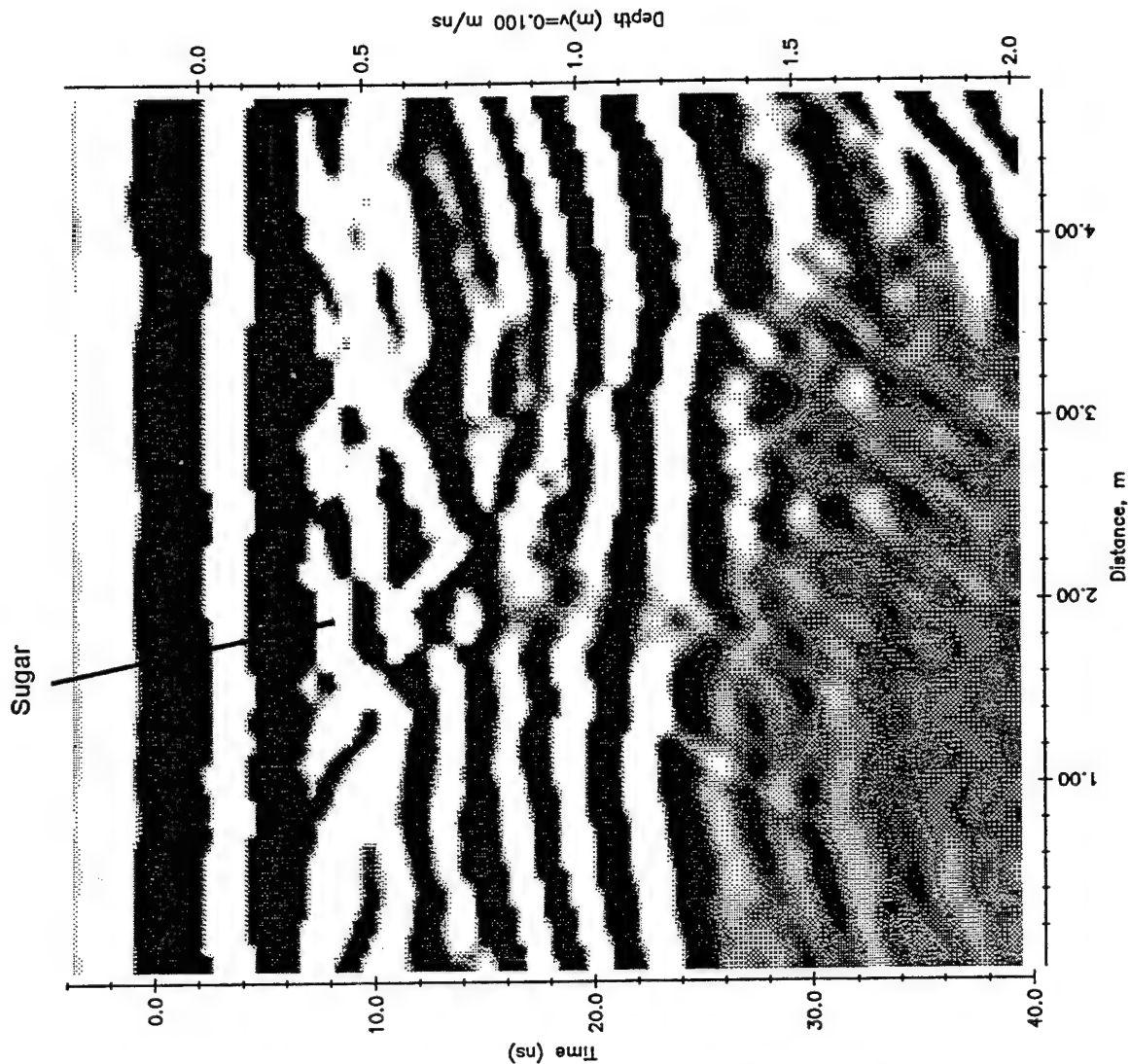
pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\21SEP0~1\CG250MS0  
 JOB# =  
 TITLE = Alabama Shipyard, Bulk Handling Area  
 DATE = 09/21/20  
 NUMBER OF TRACES = 95  
 NUMBER OF PTS/TRC = 111  
 TIMEZERO AT POINT = 11  
 TOTAL TIME WINDOW = 44  
 STARTING POSITION = 0.000  
 FINAL POSITION = 4.700  
 STEP SIZE USED = 0.050  
 POSITION UNITS = m  
 NOMINAL FREQUENCY = 250.00  
 ANTENNA SEPARATION = 0.305  
 PULSER VOLTAGE = 100  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 SELECTION TIME: -4 to 40  
 POSITIONS: 0.000 to 4.700  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.0750 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\21SEPO~1\CG250MS1  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Pumice Pile, 250 MHz, Sugar - Profile Over Sugar  
 DATE = 09/21/20  
 NUMBER OF TRACES = 96  
 NUMBER OF PTS/TRC = 111  
 TIMEZERO AT POINT = 11  
 TOTAL TIME WINDOW = 44  
 STARTING POSITION = 0.000  
 FINAL POSITION = 4.750  
 STEP SIZE USED = 0.050  
 POSITION UNITS = m  
 NOMINAL FREQUENCY = 250.00  
 ANTENNA SEPARATION = 0.305  
 PULSER VOLTAGE = 100  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
  
 PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 SELECTION TIME: -4 to 40  
 POSITIONS: 0.000 to 4.750  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000  
  
 PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.0750 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



**Appendix H**  
**Bauxite**  
**GPR Records – Buried Contraband**  
**Simulant Test**

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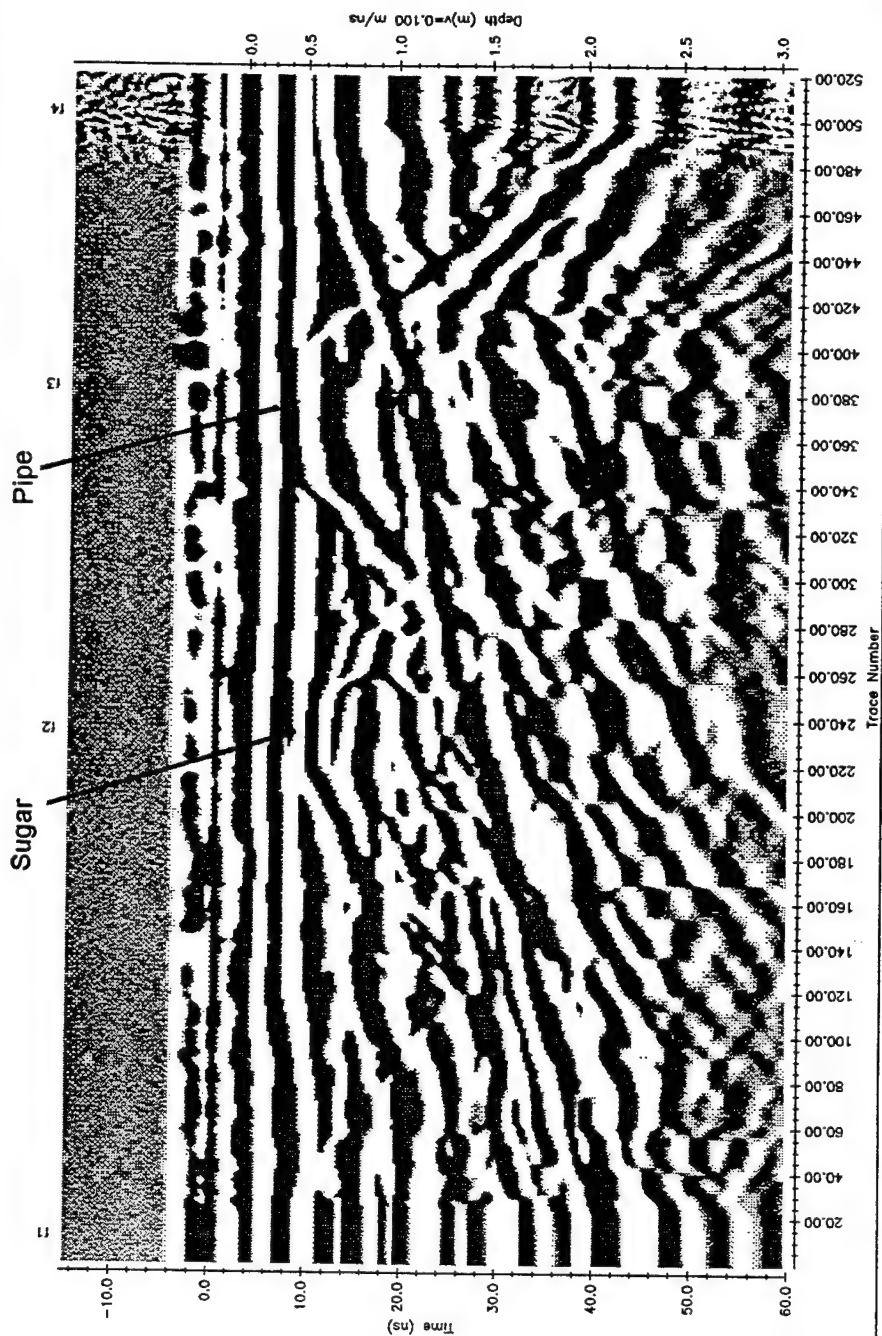
pulseEKKO HEADER PARAMETERS  
 FILE # 1\COASTG-1\21SEP0-1\CG225BS1  
 JOB # Alabama Shipyard, Bulk Handling Area  
 TITLE # Bauxite Pile, 225 MHz, Sugar - Profile Over Sugar and Pipe  
 DATE 12/1/95  
 TIME 11:19  
 NUMBER OF TRACES 521  
 NUMBER OF PTS/TRC 250  
 TIMEZERO AT POINT 51  
 TOTAL TIME WINDOW 75  
 STARTING POSITION 520.000  
 STOP POSITION 1.000  
 STOP STYLE 4  
 POSITION UNITS 225.00  
 NOMINAL FREQUENCY 225.00  
 ANTENNA SEPARATION 0.500  
 PULSER VOLTAGE 200  
 NUMBER OF STACKS 4  
 SURVEY MODE - Reflection  
 COLLECTED BY PE1000 - CON: 951119, RX: 981120  
 TX: 951121 ANT: 971195/96

#### PROCESSING SELECTED

FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 FOREGROUND: BAYOH  
 SELECTION TIME: 15.60  
 POSITIONS: 0.000 to 520.000  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

#### PLOT LAYOUT PARAMETERS

TRACE SPACING AND WIDTH: 0.0250 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 PAGES LEFT AND RIGHT: -0.5000 and 1.0000  
 BORDER SIZE: 0.000  
 BORDER WIDTH: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name=GREY Type=EA Expansion=0.500 Contour=0

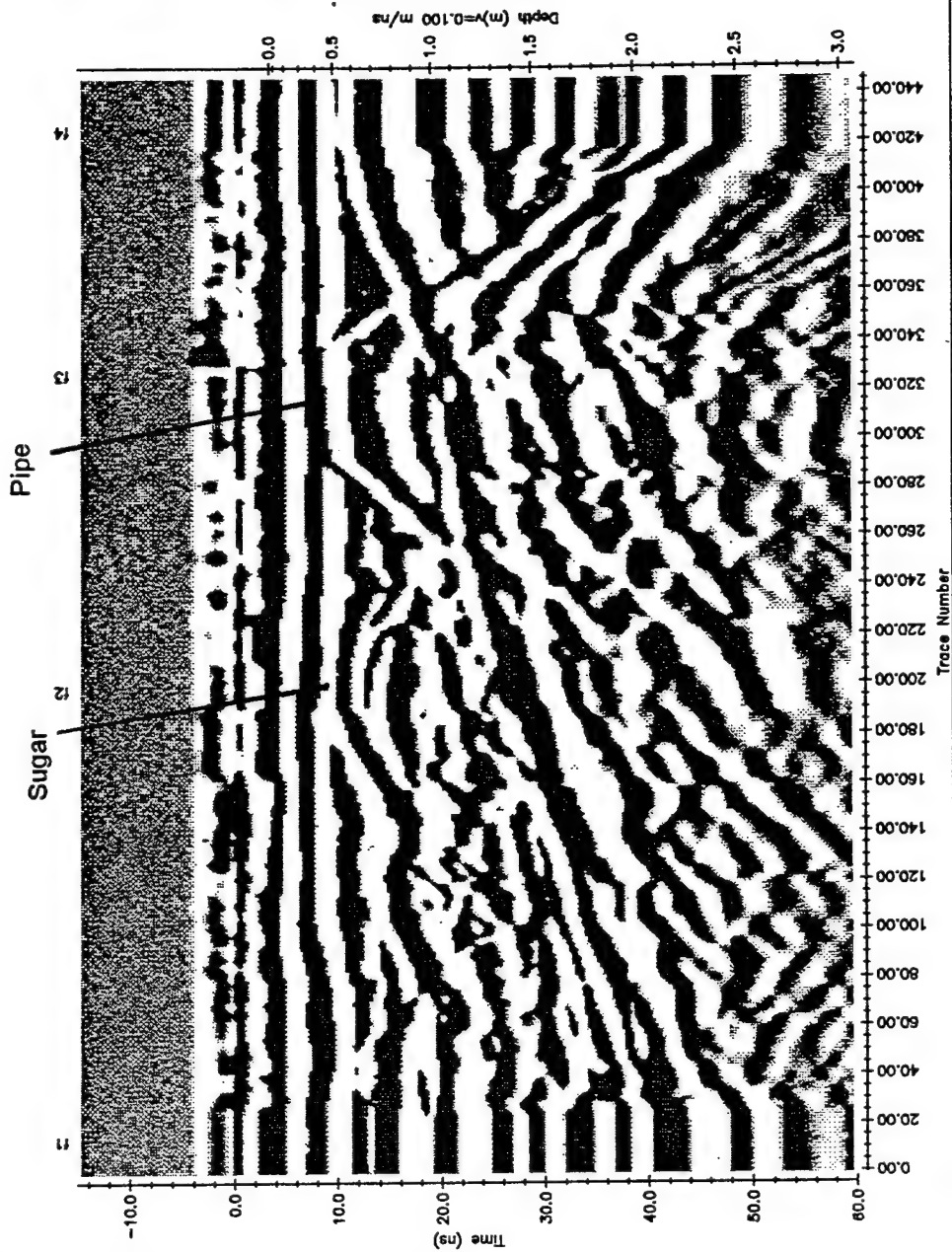




PULSE/ENKHO HEADER PARAMETERS  
 FILE = s:\COASTG-1\Z1SEF0-1\CO225BS2  
 TITLE = Alabama Shipyard, Bulk Handling Area  
 TITLE = Boxsite File, 225 MHz, Sugar - Profile Over Sugar and Pipe  
 DATE = 21/09/10  
 NUMBER OF TRACES = 447  
 NUMBER OF PTS/TRC = 250  
 TIMEZERO AT POINT = 51  
 TOTAL TIME WINDOW = 0.000  
 STARTING POSITION = 446.000  
 FINAL POSITION = 1.000  
 STEP SIZE USED = metres  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 225.00  
 ANTENNA SEPARATION = 0.500  
 NUMBER OF STACKS = 4  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971195/96

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 2  
 POINT STACKING: 2  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 SELECTION  
 TIME: -15 to 60  
 POSITIONS: 0.000 to 446.000  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

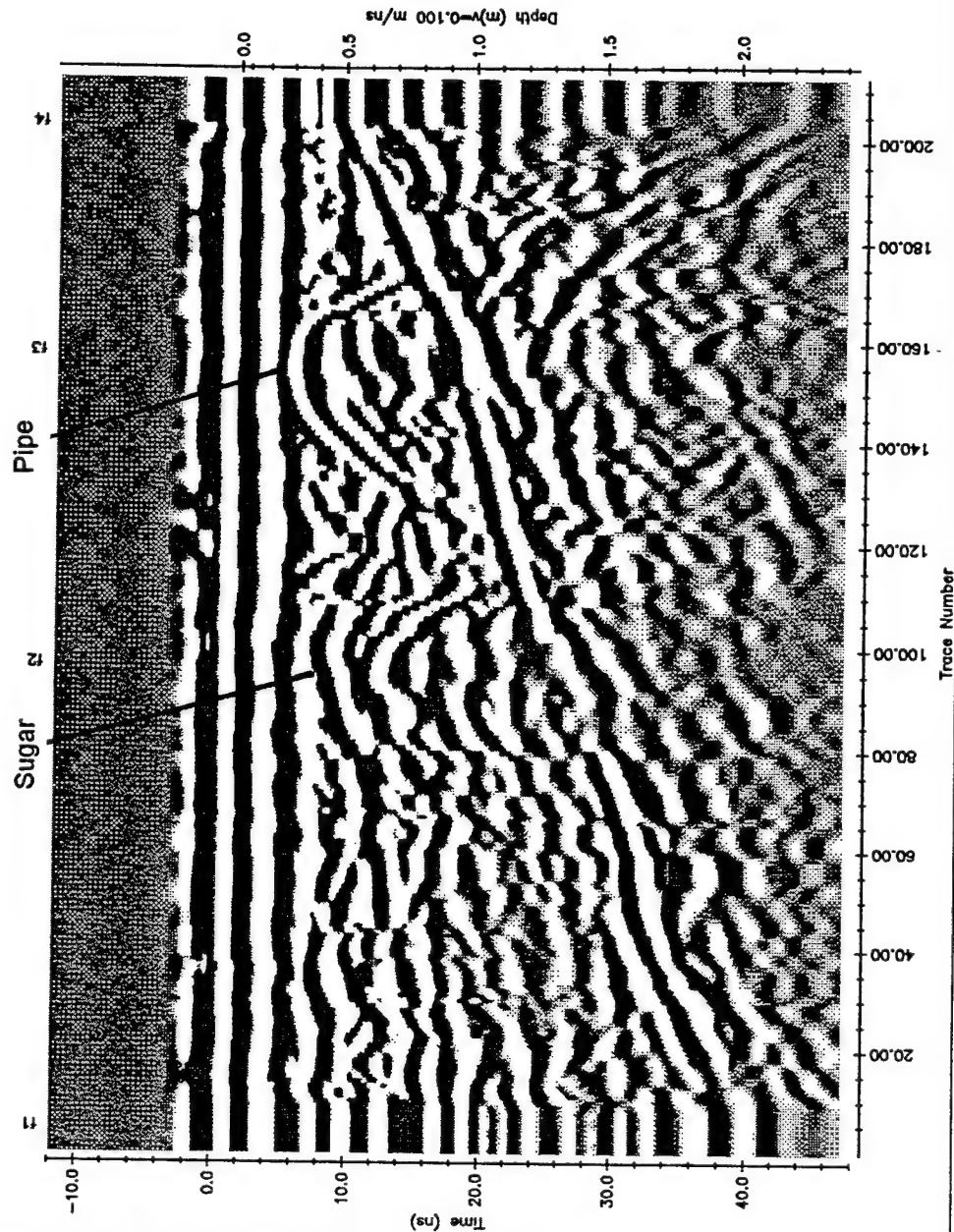
PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.0250 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\21SEP0~1\CG450BS1  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Bauxite Pile, 450 MHz, Sugar - Profile Over Sugar and Pipe  
 DATE = 21/09/10  
 NUMBER OF TRACES = 213  
 NUMBER OF PTS/TRC = 600  
 TIMEZERO AT POINT = 127  
 TOTAL TIME WINDOW = 60  
 STARTING POSITION = 0.000  
 STOP POSITION = 212.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 450.00  
 ANTENNA SEPARATION = 0.250  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 4  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 9711B1/82

PROCESSING SELECTED  
 FILTERS: TRACE STACKING: 1  
 POINT STACKING: 10  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 SELECTION TIME: -12 to 48  
 POSITIONS: 0.000 to 212.000  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

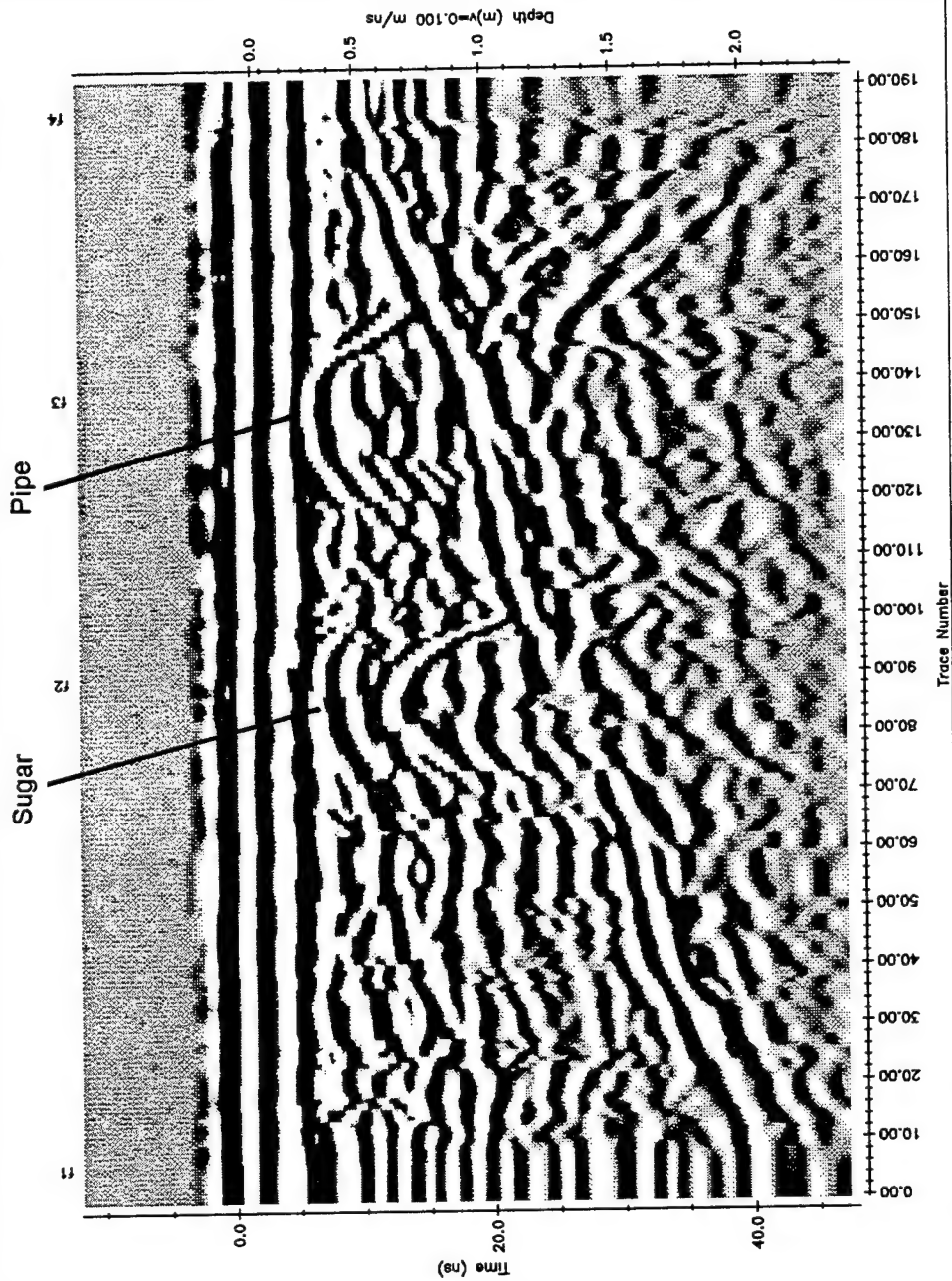
PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.0500 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 PAGE LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 1.0000  
 BORDER SIZE: 0.000  
 PRINT NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



FILE = s:\CONSTG\1\Z1SEPO\1\CG450BS2  
 JOB = Alabama Shipyard, Bulk Handling Area  
 TITLE = Bayville File, 450 MHz, Sugar - Profile Over Sugar and Pipe  
 DATE = 21/09/10  
 NUMBER OF TRACES = 192  
 NUMBER OF PTS/TRC = 600  
 TIMEZERO AT POINT = 127  
 TOTAL TIME WINDOW = 60  
 STARTING POSITION = 0.000  
 FINAL POSITION = 191.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 450.000  
 NOMINAL SEPARATION = 0.250  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 4  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971181/82

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 1  
 POINT STACKING: 10  
 TRACE DIRECTION: N  
 CORRECTION: DEWOW  
 TIME: 12 to 48  
 SELECTION POSITIONS: 0.000 to 191.000  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

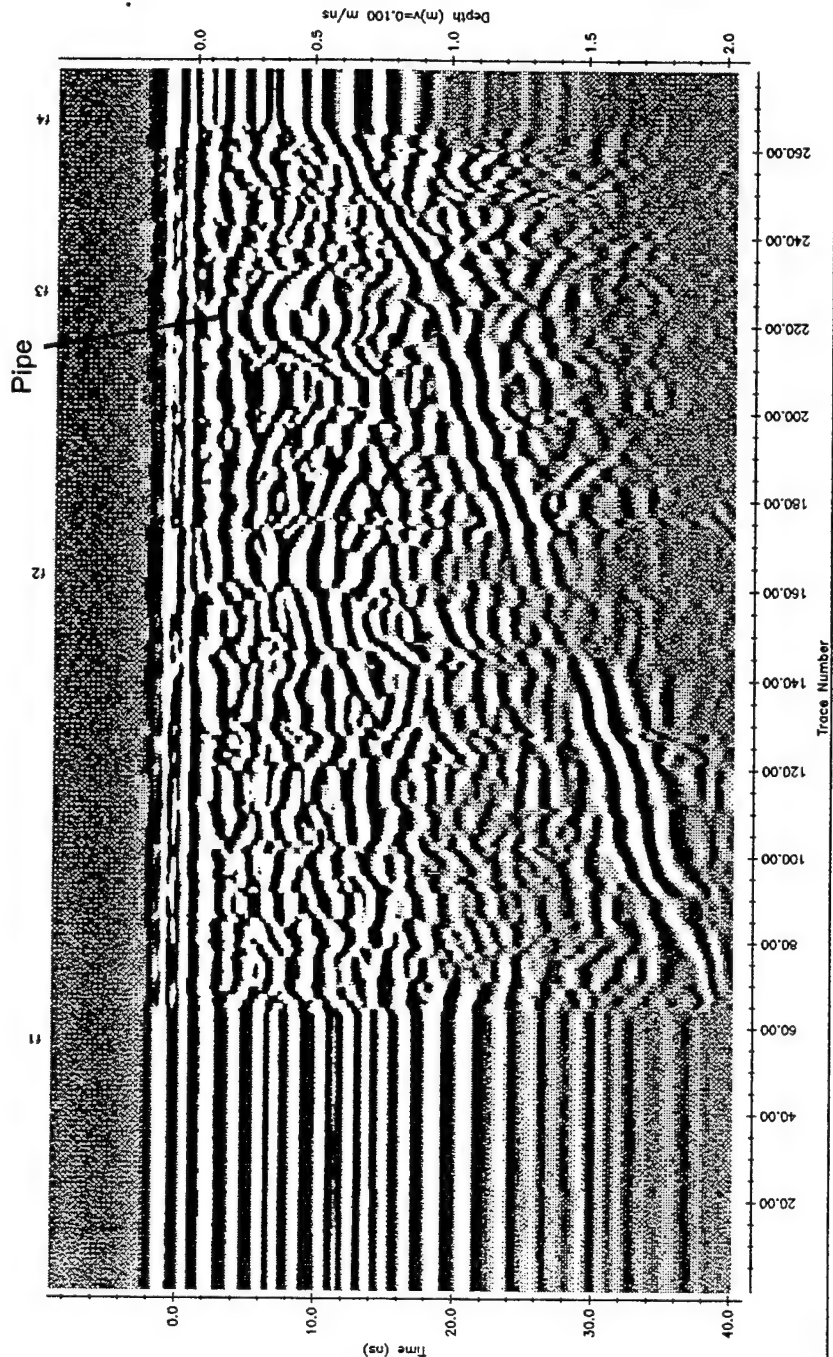
PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.0600 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 PAPER WIDTH AND HEIGHT: -0.5000 and 1.0000  
 BORDER WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKO HEADER PARAMETERS  
 FILE = s:\CONSTG-1\21SEP0-1\CG900BS1  
 JOB = Alabama Shipyard, Bulk Handling Area  
 TITLE = Bauxite Pile, 900 MHz, Sugar - Profile Over Sugar and Pipe  
 DATE = 21/09/10  
 NUMBER OF TRACES = 279  
 NUMBER OF PTS/TRC = 500  
 NUMBER OF POINTS = 50  
 TOTAL TIME WINDOW = 0.000  
 STARTING POSITION = 278.000  
 FINAL POSITION = 1.000  
 STEP SIZE USED = 0.001  
 CORRELATION FREQUENCY = 500.000  
 NOMINAL FREQUENCY = 900.000  
 ANTENNA SEPARATION = 0.170  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 4  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 991119, RX: 991129  
 TX: 991121 ANT: 971236/59

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 1  
 TRACE SMOOTHING: 3  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 SELECTION  
 TIME: -9 to 41  
 POSITIONS: 0.000 to 278.000  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

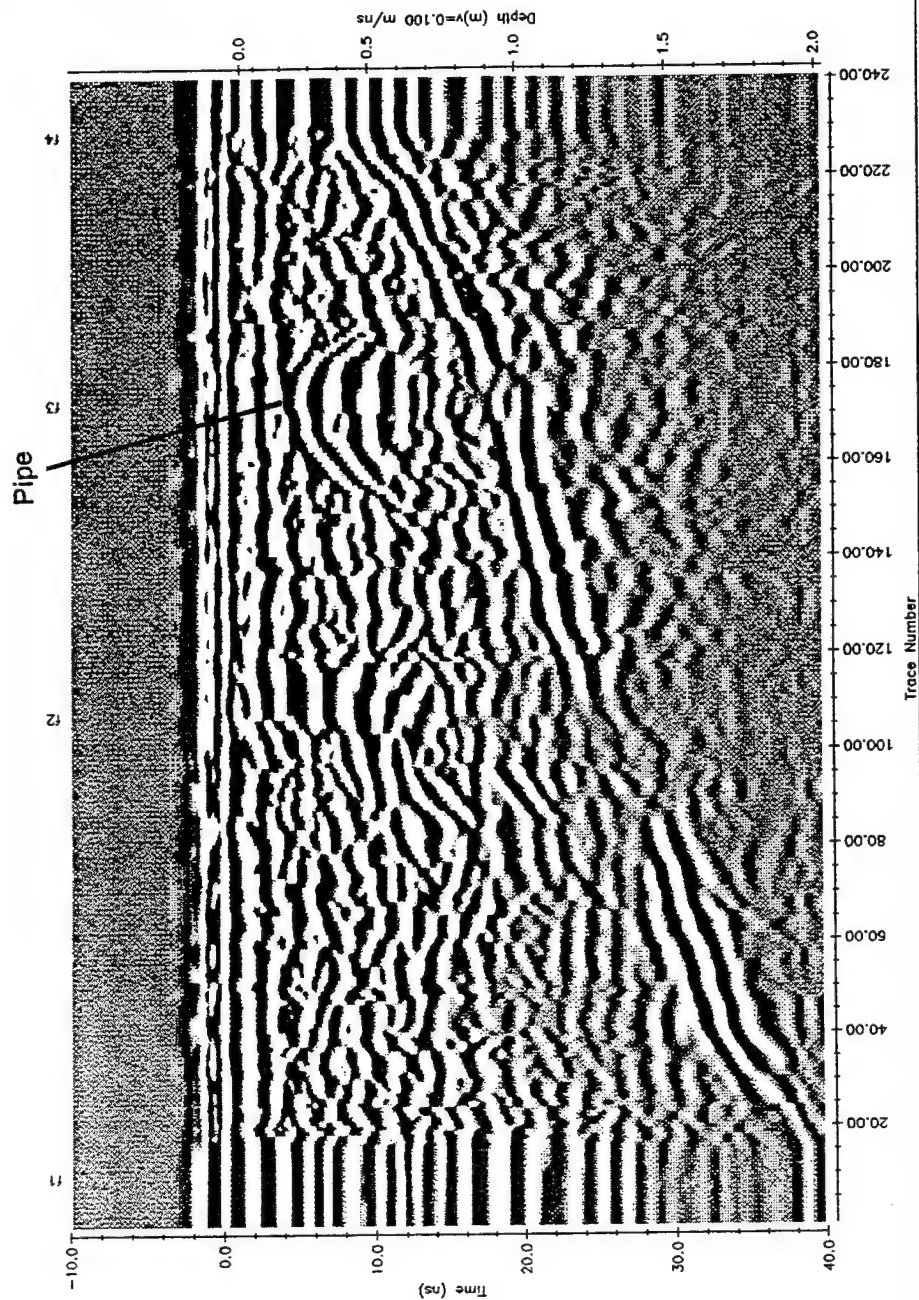
PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.0500 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
 PAGE WIDTH: 10.0000  
 PAPER SIZE: 0.0000  
 PRINTER NAME: 0.0000  
 SCALE BAR: Name: GREY Type: EA Expansion: 0.500 Contour: 0



PULSEKHO HEADER PARAMETERS  
 FILE = s:\COASTG-1\21SEP0-1\CG900BS2  
 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Bouxite Pile, 900 MHz, Sugar - Profile Over Sugar and Pipe  
 DATE = 21/09/10  
 TIME = 11:00:00  
 NUMBER OF PTS/CYC = 241  
 NUMBER OF CYCLES = 500  
 TIME ZERO AT POINT = 102  
 TOTAL TIME WINDOW = 50  
 STARTING POSITION = 0.000  
 FINAL POSITION = 240.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 900.00  
 ANTENNA SEPARATION = 0.170  
 PULSER VOLTAGE = 200  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971258/59

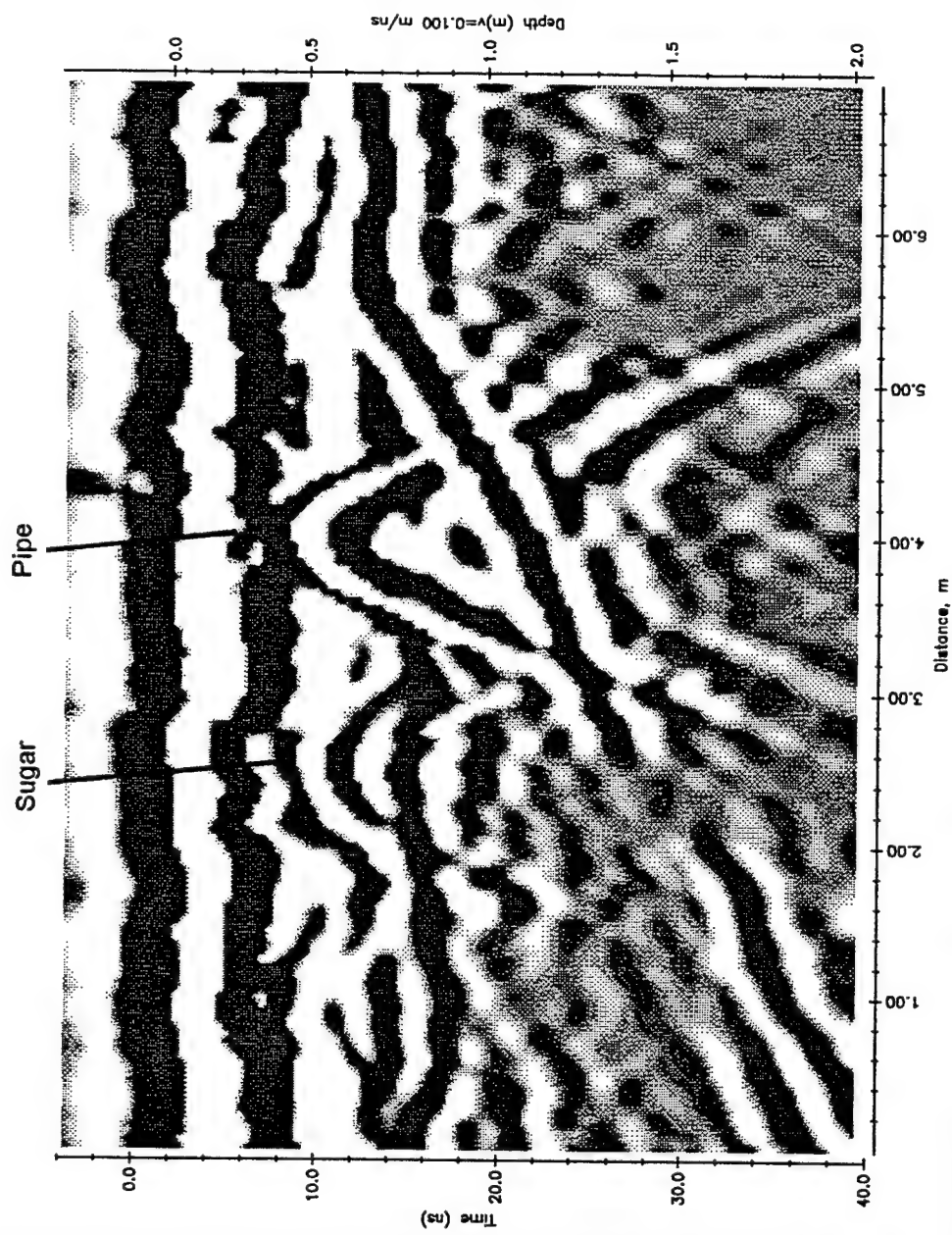
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 SELECTION  
 POSITIONS: 0.000 to 240.000  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS  
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 JOB# = Alabama Shipyard, Bulk Handling Area  
 TITLE = Bauxite Pile, 250 MHz, Sugar - Profile Over Sugar and Pipe  
 DATE = 09/21/20  
 NUMBER OF TRACES = 140  
 NUMBER OF PIS/TRC = 111  
 TIME ZERO AT POINT = 4.11  
 TIME ZERO WINDOW = 4.00  
 STARTING POSITION = 6.950  
 FINAL POSITION = 0.050  
 STEP SIZE USED = 0.050  
 POSITION UNITS = 0.050  
 NOMINAL FREQUENCY = 250.00  
 ANTENNA SEPARATION = 0.305  
 PULSER VOLTAGE = 100  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection  
 PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 1  
 POINT STACKING: 5  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 SELECTION TIME: -4 to 40  
 POSITIONS: 0.000 to 6.950  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000  
 PLOT LAYOUT PARAMETERS  
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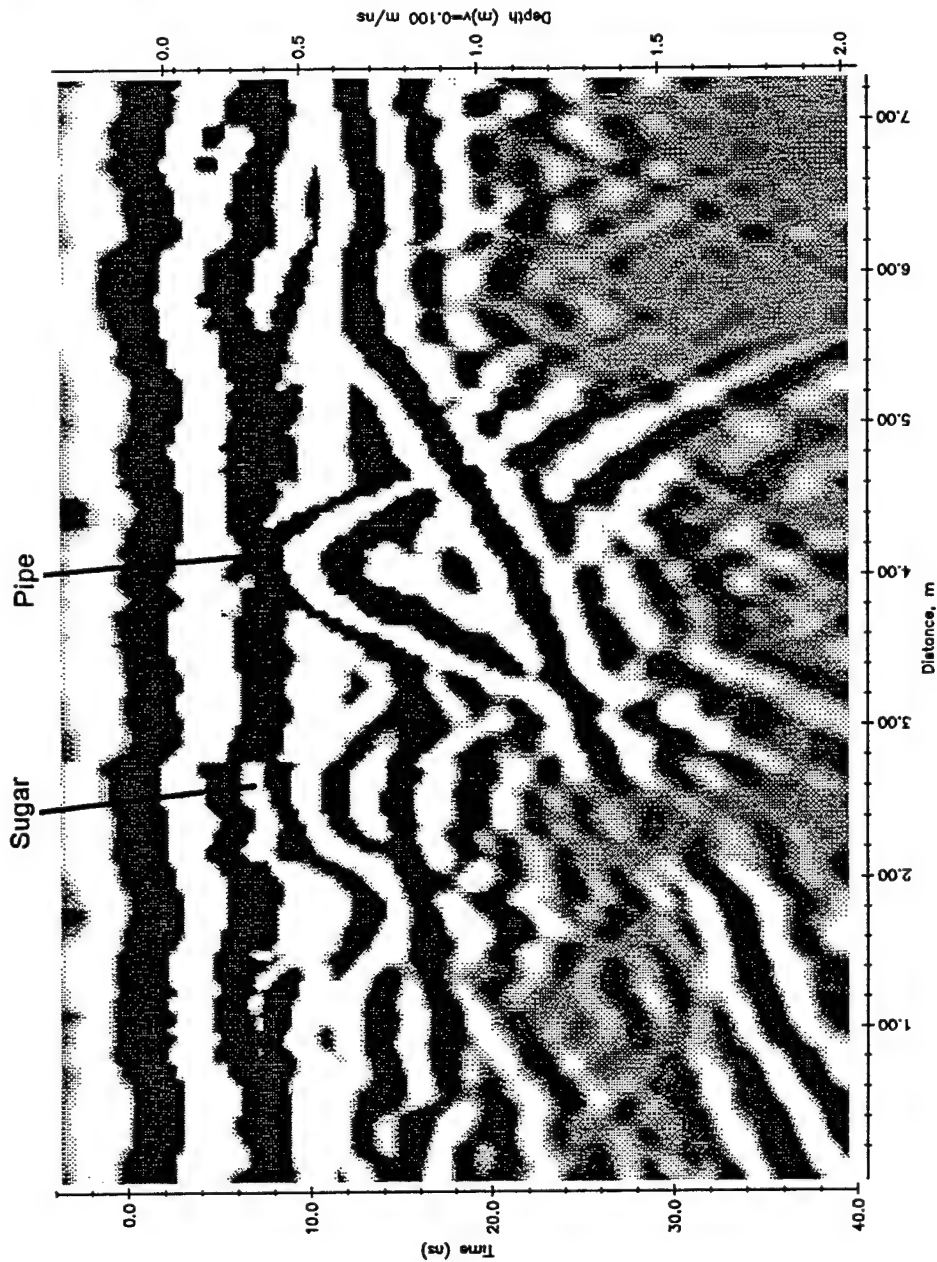




PULSEKHO HEADER PARAMETERS  
 FILE = s:\COASTG-1\21SEP0~\NCG250BS1  
 JOB = Alabama Shipyard, Bulk Handling Area  
 TITLE = Bauxite Pile, 250 MHz, Sugar - Profile Over Sugar and Pipe  
 DATE = 09/21/20  
 NUMBER OF TRACES = 146  
 NUMBER OF PTS/TRC = 111  
 TIMEZERO AT POINT = 11  
 TOTAL TIME WINDOW = 44  
 STARTING POSITION = 0.000  
 FINAL POSITION = 7.250  
 STEP SIZE USED = 0.050  
 POSITION UNITS = m  
 NOMINAL FREQUENCY = 250.00  
 ANTENNA SEPARATION = 0.305  
 PILE DETECTION = 10  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 1  
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 CORRECTION: DEWOW  
 SELECTION TIME: -4 to 40  
 POSITIONS: 0.000 to 7.250  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS  
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**Appendix I**

**Coal**

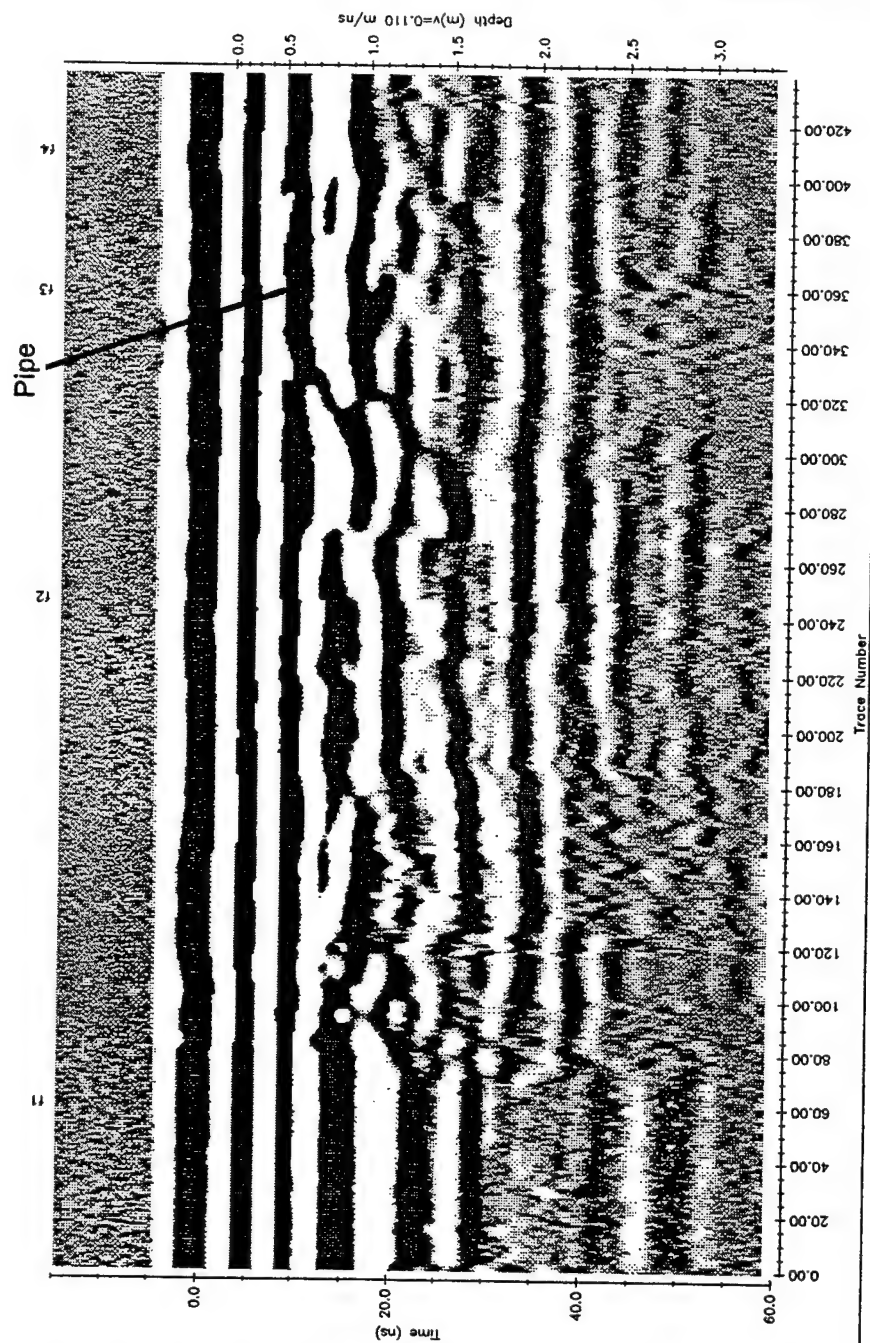
**GPR Records – Buried Contraband  
Simulant Test**

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PULSEKHO HEADER PARAMETERS  
 FILE: \\COASTG-1\21SEP0-1\CG2251.S1  
 JOB: U.S. Coast Guard  
 TITLE: Cool Pipe (second), 225 MHz, Sugar  
 DATE: 21/09/95  
 TIME: 11:10  
 NUMBER OF TRACES: 439  
 NUMBER OF PTS/TRC: 230  
 TIMEZERO AT POINT: 53  
 TOTAL TIME WINDOW: 75  
 STARTING POSITION: 0.000  
 FINISH POSITION: 1.000  
 STEP SIZE USED: 0.000  
 POSITION UNITS: metres  
 NOMINAL FREQUENCY: 225.00  
 ANTENNA SEPARATION: 0.500  
 PULSER VOLTAGE: 200  
 NUMBER OF STACKS: 4  
 SURVEY MODE: Reflection  
 COLLECTED BY: PE1000 - CON: 881119 PX: 981120  
 TX: 881121 ANT: 971195/95

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 MULTIPLIER: 100.000

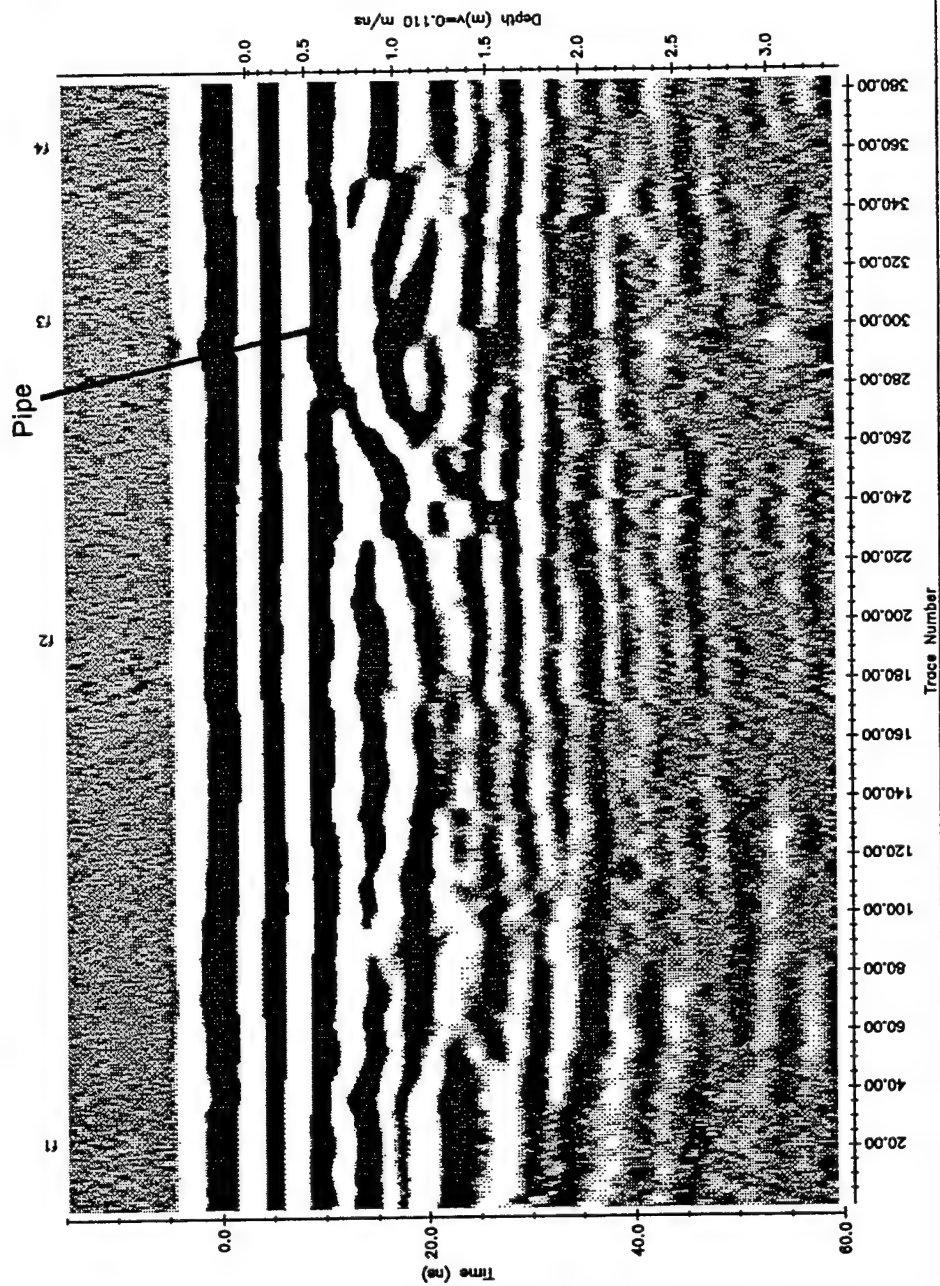
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 FILE = s:\COASTG\1\21SEP0~1\CG225LS2  
 JOB# = 1  
 TITLE = U.S. Coast Guard  
 DATE = 21/09/10  
 TIME = 09:10 (second), 225 MHz, Sugar  
 NUMBER OF TRACES = 384  
 NUMBER OF PTS/TRC = 250  
 TIMEZERO AT POINT = 52  
 TOTAL TIME WINDOW = 75  
 STARTING POSITION = 0.000  
 FINAL POSITION = 383.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 225.000  
 ANTENNA RETENTION = 0.000  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 4  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971195/96

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 1  
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 TRACE DIFFERENCING: N  
 CORRECTION: BROW  
 TIME CORRECTION: 0.000  
 POSITIONS: 0.000 to 383.000  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

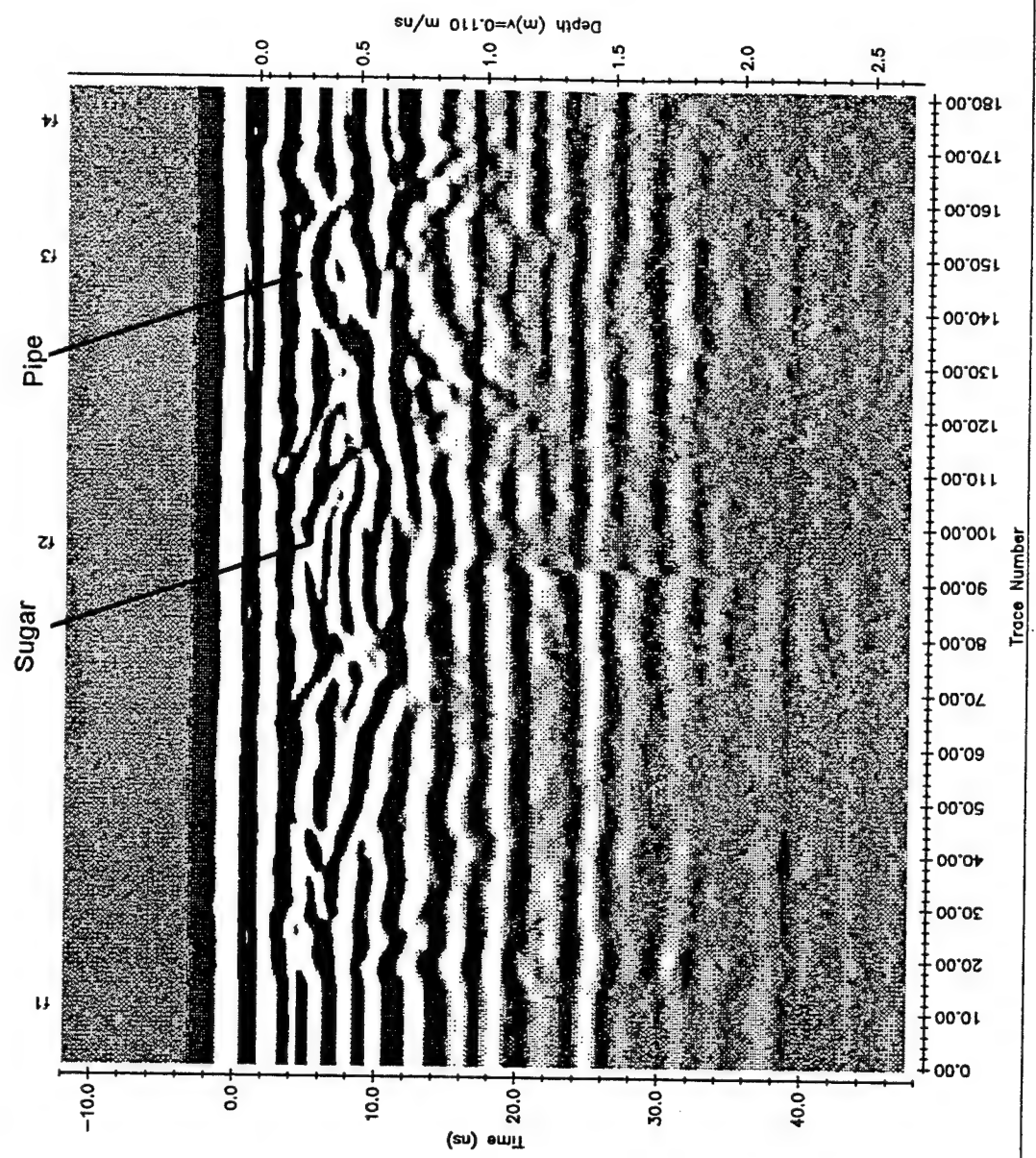
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pulseKHO HEADER PARAMETERS  
 FILE = s:\COASTC~1\21SEP0~1\CG450LS1  
 JOB# = U.S. Coast Guard  
 TITLE = Coal Pile (second), 450 MHz, Sugar  
 DATE = 21/09/10  
 NUMBER OF TRACES = 182  
 NUMBER OF PTS/TRC = 600  
 TIMEZERO AT POINT = 126  
 TOTAL TIME WINDOW = 60  
 STARTING POSITION = 0.000  
 FINAL POSITION = 181.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 450.00  
 ANTENNA SEPARATION = 0.250  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 4  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971181/82

PROCESSING SELECTED  
 FILTERS: TRACE STACKING: 1  
 POINT STACKING: 5  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -12 to 48  
 POSITIONS: 0.000 to 181.000  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS  
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 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
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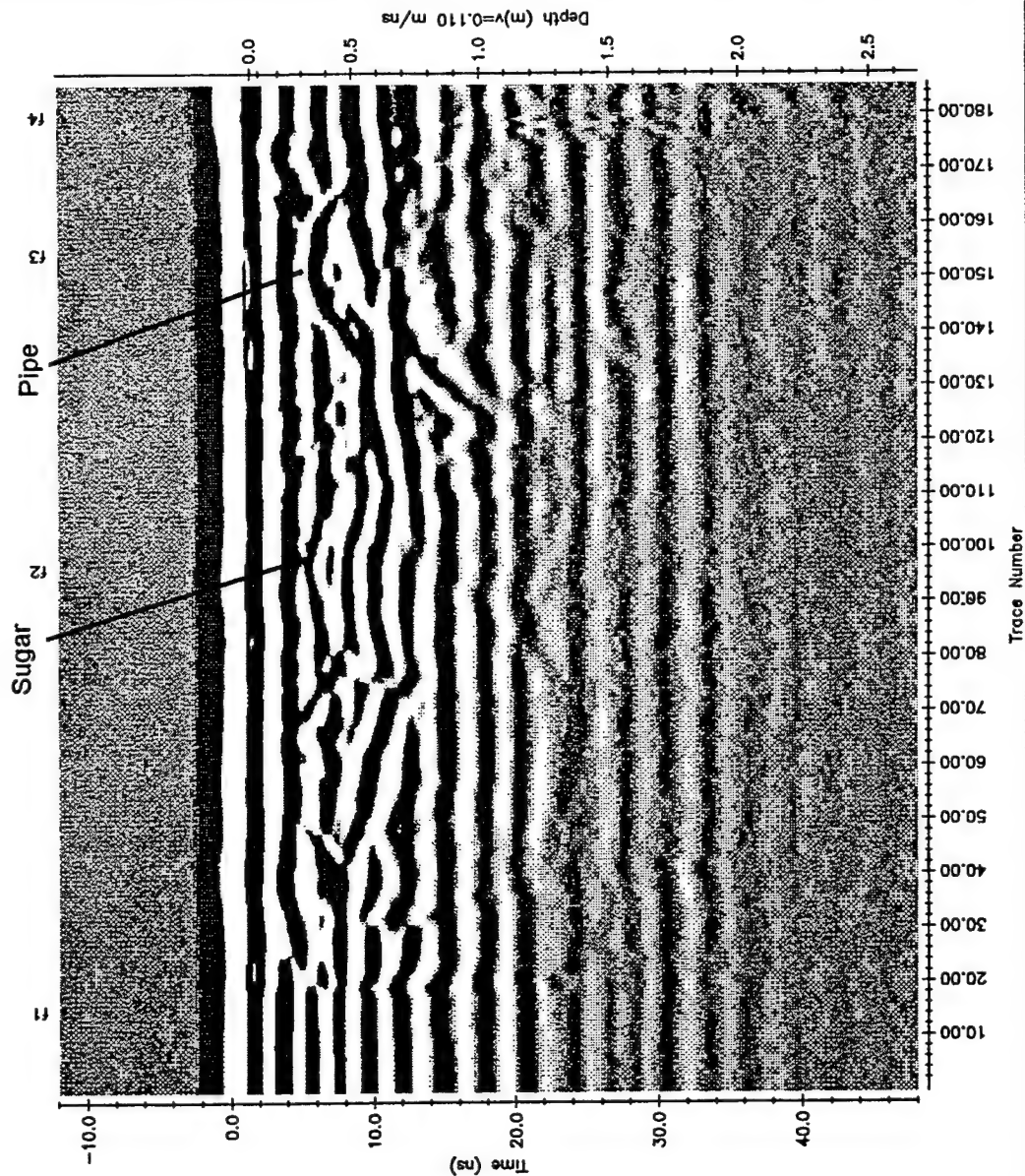




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 JOB# = U.S. Coast Guard  
 TITLE = Coal Pile (second), 450 MHz, Sugar  
 DATE = 21/09/10  
 NUMBER OF TRACES = 186  
 NUMBER OF PTS/TRC = 600  
 TIMEZERO AT POINT = 120  
 TOTAL TIME WINDOW = 60  
 STARTING POSITION = 0.000  
 FINAL POSITION = 185.000  
 STEP SIZE USED = 1.000 metres  
 POSITION UNITS = metres  
 NOMINAL FREQUENCY = 450.000  
 ANTENNA SEPARATION = 0.250  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 4  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971181/82

PROCESSING SELECTED  
 FILTERS: TRACE STACKING: 1  
 POINT STACKING: 5  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -12 to 48  
 SELECTION POSITIONS: 0.000 to 185.000  
 GAINS: GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS  
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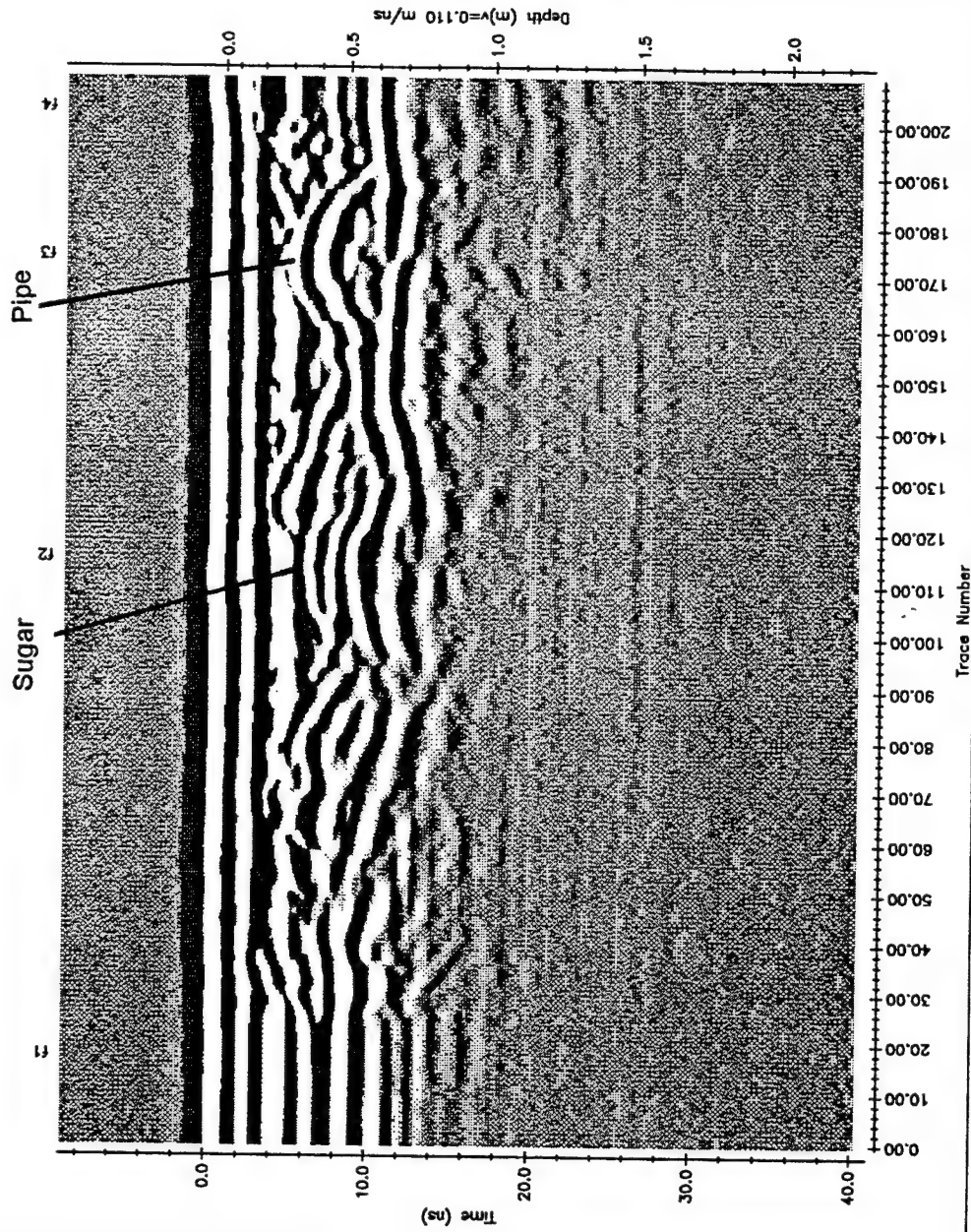




pulsedEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\21SEPO~1\CG900LS1  
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 TITLE = Coal Pile (second), 900 MHz, Sugar  
 DATE = 21/09/10  
 NUMBER OF TRACES = 210  
 NUMBER OF PTS/TRC = 500  
 TIMEZERO AT POINT = 97  
 TIME WINDOW = 50  
 STARTING POSITION = 0.000  
 FINAL POSITION = 209.000  
 STEP SIZE USED = 1.000  
 POSITION UNITS = Meters  
 NOMINAL FREQUENCY = 900.000  
 ANTENNA SEPARATION = 0.170  
 PULSER VOLTAGE = 200  
 NUMBER OF STACKS = 4  
 SURVEY MODE = Reflection  
 COLLECTED BY PE1000 - CON: 981119 RX: 981120  
 TX: 981121 ANT: 971258/59

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 1  
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 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -9 to 41  
 SELECTION  
 POSITIONS: 0.000 to 209.000  
 GAINS  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS  
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# pulseKHO HEADER PARAMETERS

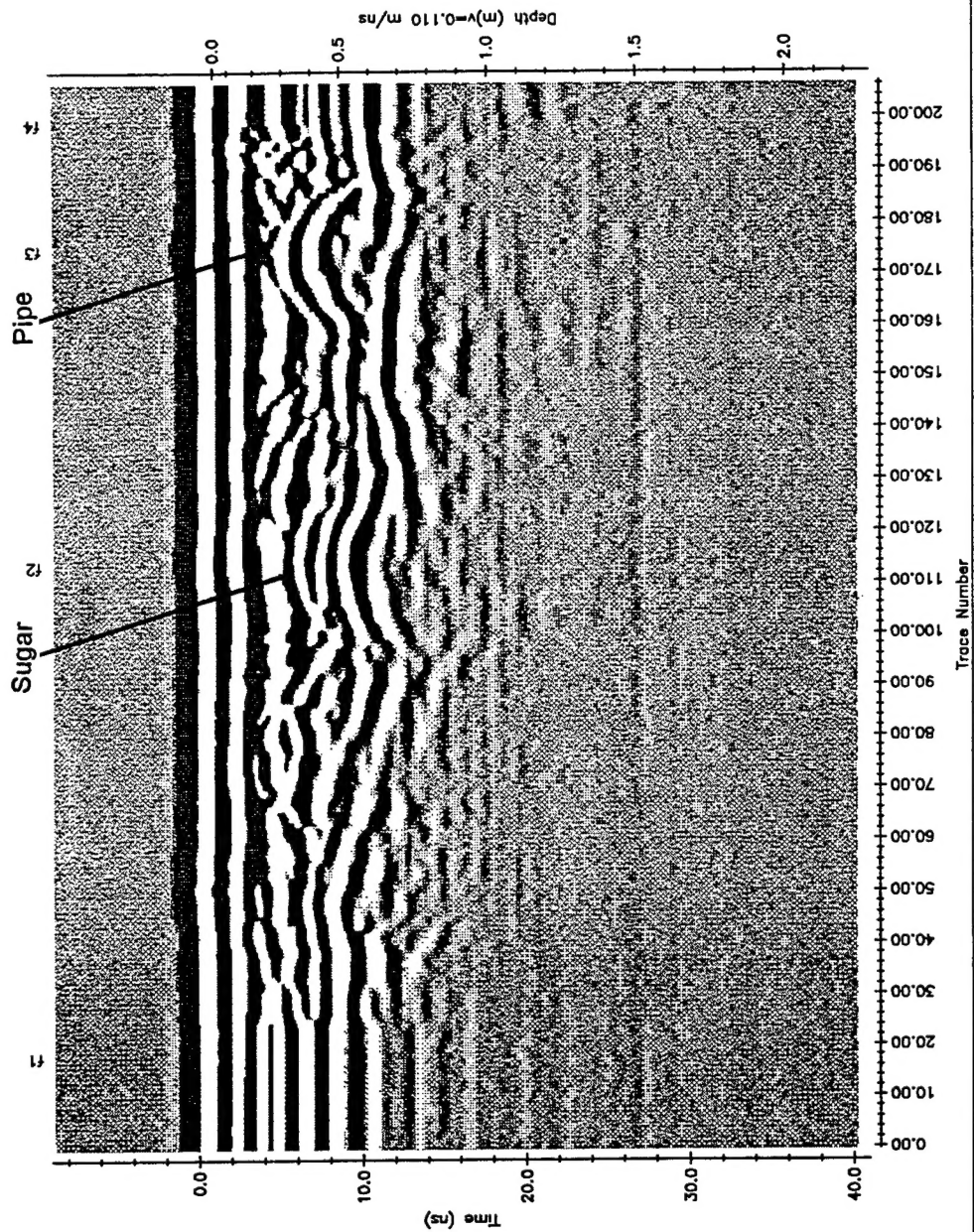
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 JOB# = U.S. Coast Guard  
 TITLE = Coal Pile (second), 900 MHz, Sugar  
 DATE = 21/09/10  
 NUMBER OF TRACES = 207  
 NUMBER OF PTS/TRC = 500  
 TIMEZERO AT POINT = 50  
 TOTAL TIME WINDOW = 0.000  
 STARTING POSITION = 206.000  
 FINAL POSITION = 1.000  
 STEP SIZE USED = metres  
 POSITION UNITS = 900.00  
 NOMINAL FREQUENCY = 0.170  
 ANTENNA SEPARATION = 200  
 PULSER VOLTAGE = 4  
 NUMBER OF STACKS = Reflection  
 SURVEY MODE = CON: 981119 RX: 981120  
 COLLECTED BY PE1000 - TX: 981121 ANT: 971258/59

## PROCESSING SELECTED

FILTERS:  
 TRACE STACKING: 1  
 POINT STACKING: 5  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 TIME: -9 to 41  
 POSITIONS: 0.000 to 206.000  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

## PLOT LAYOUT PARAMETERS

TRACE SPACING AND WIDTH: 0.0500 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
 MARGIN LEFT AND RIGHT: -0.5000 and 1.0000  
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 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0

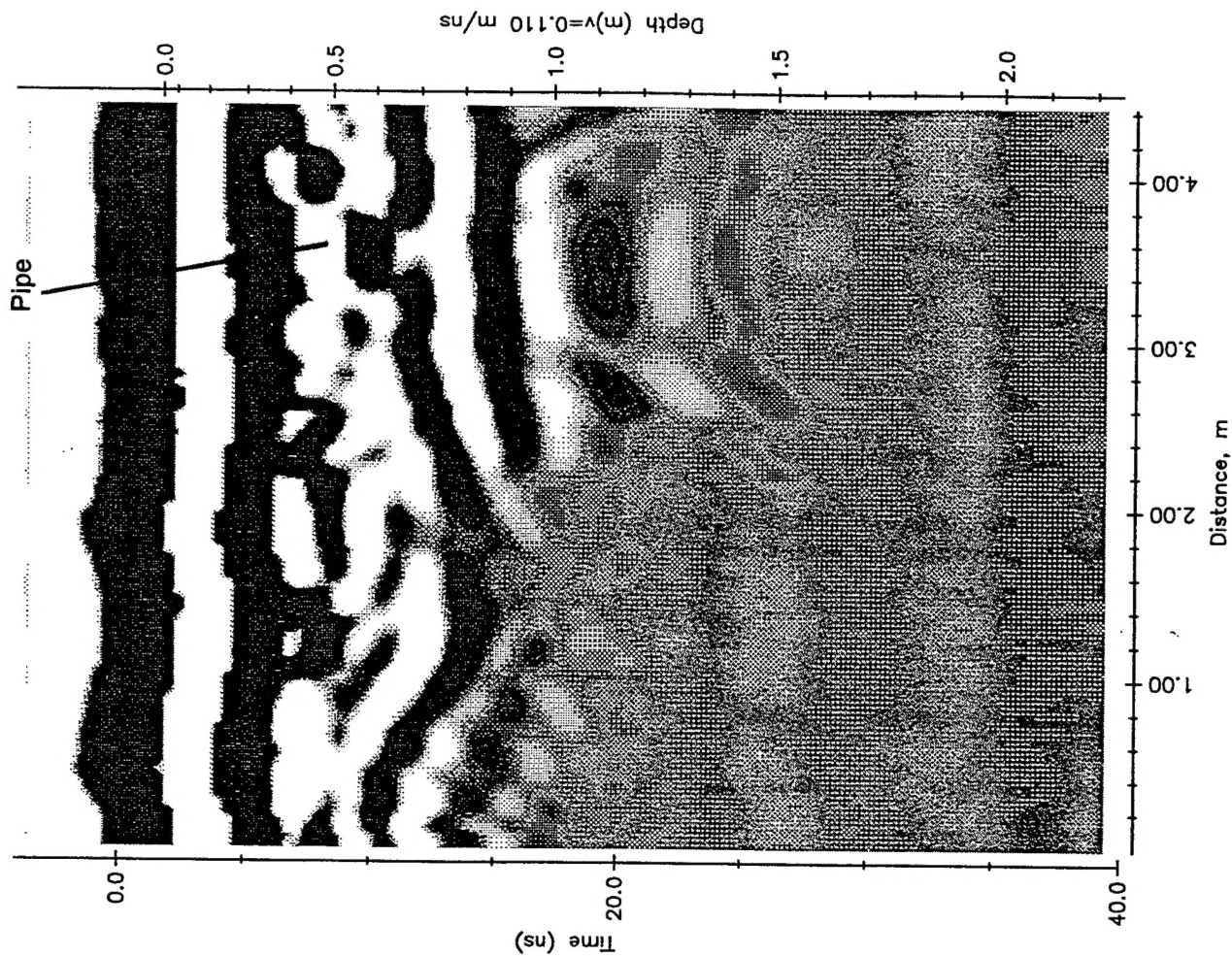


pulseEKKO HEADER PARAMETERS  
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 TITLE = Data Collected with Noggin Plus

DATE = 09/21/20  
 NUMBER OF TRACES = 89  
 NUMBER OF PTS/TRC = 111  
 TIMEZERO AT POINT = 11  
 TOTAL TIME WINDOW = 44  
 STARTING POSITION = 0.000  
 FINAL POSITION = 4.400  
 STEP SIZE USED = 0.050  
 POSITION UNITS = m  
 NOMINAL FREQUENCY = 250.00  
 ANTENNA SEPARATION = 0.305  
 PULSER VOLTAGE = 100  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection

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 TRACE DIFFERENCING: N  
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 MULTIPLIER: 100.000

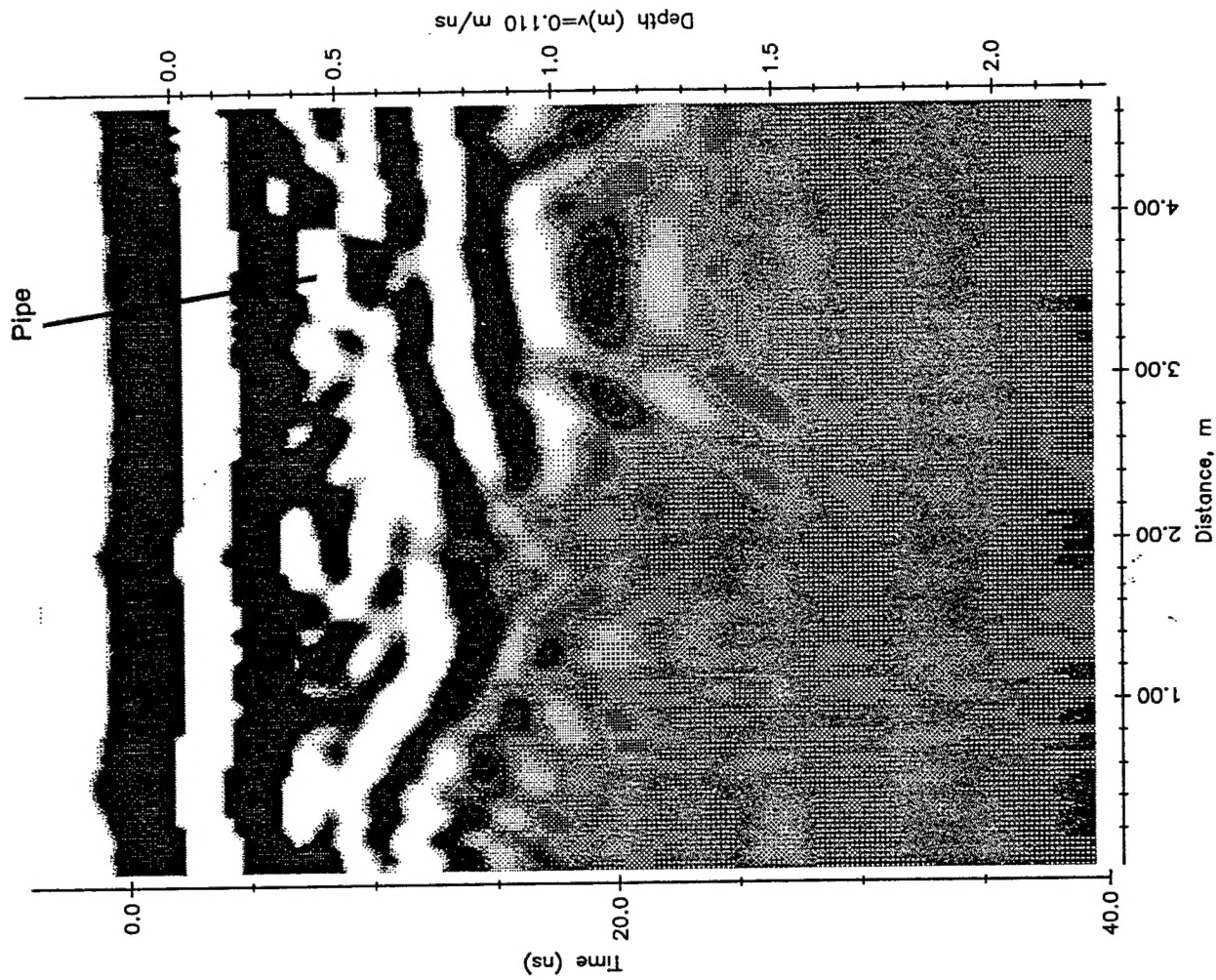
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 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS  
 FILE = s:\COASTG~1\21SEPO~1\CG250LS1  
 JOB# = 1234  
 TITLE = Data Collected with Noggin Plus  
 DATE = 09/21/20  
 NUMBER OF TRACES = 94  
 NUMBER OF PTS/TRC = 111  
 TIMEZERO AT POINT = 11  
 TOTAL TIME WINDOW = 44  
 STARTING POSITION = 0.000  
 FINAL POSITION = 4.650  
 STEP SIZE USED = 0.050  
 POSITION UNITS = m  
 NOMINAL FREQUENCY = 250.00  
 ANTENNA SEPARATION = 0.305  
 PULSER VOLTAGE = 100  
 NUMBER OF STACKS = 16  
 SURVEY MODE = Reflection

PROCESSING SELECTED  
 FILTERS:  
 TRACE STACKING: 1  
 POINT STACKING: 5  
 TRACE DIFFERENCING: N  
 CORRECTION: DEWOW  
 SELECTION TIME: -4 to 40  
 POSITIONS: 0.000 to 4.650  
 GAINS:  
 GAIN TYPE: CONSTANT  
 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS  
 TRACE SPACING AND WIDTH: 0.0600 and 0.2500  
 TRACE BOTTOM AND TOP: 1.0000 and 9.0000  
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 PAGE WIDTH: 10.0000  
 BORDER SIZE: 0.000  
 PRINTER NAME: LAS300  
 SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0





**REPORT DOCUMENTATION PAGE**Form Approved  
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<b>1. REPORT DATE (DD-MM-YYYY)</b> August 2001		<b>2. REPORT TYPE</b> Final Report		<b>3. DATES COVERED (From - To)</b>	
<b>4. TITLE AND SUBTITLE</b> Use of Ground Penetrating Radar for Locating Contraband Aboard Ocean Going Vessels: Feasibility Study				<b>5a. CONTRACT NUMBER</b>	
				<b>5b. GRANT NUMBER</b>	
				<b>5c. PROGRAM ELEMENT NUMBER</b>	
				<b>5d. PROJECT NUMBER</b>	
<b>6. AUTHOR(S)</b> José L. Llopis, Janet Simms				<b>5e. TASK NUMBER</b>	
				<b>5f. WORK UNIT NUMBER</b>	
				<b>8. PERFORMING ORGANIZATION REPORT NUMBER</b>  ERDC/GSL TR-01-12	
<b>7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)</b>  U.S. Army Engineer Research and Development Center Geotechnical and Structures Laboratory 3909 Halls Ferry Road Vicksburg, MS 39180-6199				<b>10. SPONSOR/MONITOR'S ACRONYM(S)</b>	
				<b>11. SPONSOR/MONITOR'S REPORT NUMBER(S)</b>	
<b>9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)</b> U.S. Coast Guard Research and Development Center 1082 Shennecossett Road Groton, CT 06340					
<b>12. DISTRIBUTION / AVAILABILITY STATEMENT</b> Approved for public release; distribution is unlimited.					
<b>13. SUPPLEMENTARY NOTES</b>					
<b>14. ABSTRACT</b> <p>Ground Penetrating Radar (GPR) surveys were conducted over various stockpiled materials at the Alabama State Docks located in Mobile, AL, to determine whether GPR is a viable method for rapidly detecting contraband materials buried in the cargo holds of ocean going vessels. The surveys were conducted by burying various objects including a contraband simulant (a bundle of four 10-lb bags of sugar duct-taped together) in stockpiled materials available at the site. The stockpiled materials tested were crystal gypsum, powdered gypsum, crushed pumice, coarse coal, fine coal, and bauxite.</p> <p>Two GPR systems, the pulseEKKO 1000 and the Noggin Plus systems, manufactured by Sensors &amp; Software, Inc., were used to conduct the surveys. GPR surveys were run over the stockpiled materials using a suite of antenna frequencies ranging between 225 and 900 MHz to determine the effects of material type on depth of penetration and target resolution.</p> <p>All of the antennas tested were successful in detecting the location of the contraband simulant in at least one of the stockpiled materials. The 225 and 250 MHz antennas had the highest percentage of detecting the simulant in the stockpiled materials (60 and 90 percent, respectively) whereas the 900 MHz antenna had the lowest (30 percent). All antennas tested have penetration depths of greater than 1.5 m.</p> <p>The GPR surveys run on the different stockpiled materials at the Alabama State Docks demonstrate that GPR is a feasible means of locating contraband buried to depths of at least 1 to 2 m (limit of testing). However, the probability of success of locating contraband with GPR on board ships depends on the size and depth of the target as well as the magnetic and electrical properties of the target and the material in which it is hidden.</p>					
<b>15. SUBJECT TERMS</b> Conductivity      Detection      Ground Penetrating Radar (GPR) Contraband      Geophysics					
<b>16. SECURITY CLASSIFICATION OF:</b>			<b>17. LIMITATION OF ABSTRACT</b>	<b>18. NUMBER OF PAGES</b>  149	<b>19a. NAME OF RESPONSIBLE PERSON</b>
<b>a. REPORT</b> UNCLASSIFIED	<b>b. ABSTRACT</b> UNCLASSIFIED	<b>c. THIS PAGE</b> UNCLASSIFIED			<b>19b. TELEPHONE NUMBER (include area code)</b>